

ExtremeXOS® Concepts Guide

Software Version 15.2

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Preface

This chapter provides an overview of this guide, describes the conventions used in the guide, and lists other publications that might be useful.

Introduction

This guide provides the required information to configure ExtremeXOS® software in the currently supported versions running on switches from Extreme Networks®.

This guide is intended for use by network administrators who are responsible for installing and setting up network equipment. Working knowledge of the following is assumed:

- Local area networks (LANs)
- Ethernet concepts
- Ethernet switching and bridging concepts
- Routing concepts
- Internet Protocol (IP) concepts
- Routing Information Protocol (RIP), Open Shortest Path First (OSPF), and Intermediate System-Intermediate System (IS-IS)
- Border Gateway Protocol (BGP-4) concepts
- IP multicast concepts
- Protocol Independent Multicast (PIM) concepts
- Simple Network Management Protocol (SNMP)



NOTE

If the information in the release notes shipped with your switch differs from the information in this guide, follow the release notes.

Terminology

When features, functionality, or operation is specific to a switch family, the family name is used. Explanations about features and operations that are the same across all product families simply refer to the product as the “switch.”

Conventions

This section describes conventions used in the documentation:

- [Platform-Dependent Conventions on page 32](#)
- [Text Conventions on page 32](#)

Platform-Dependent Conventions

Unless otherwise noted, *all* information applies to *all* platforms supported by ExtremeXOS software, which are the following:

- BlackDiamond® X8 X-series switch
- BlackDiamond 8800 series switches
- Cell Site Routers (E4G-200 and E4G-400)
- Summit® family switches
- SummitStack™

When a feature or feature implementation applies to *specific* platforms, the specific platform is noted in the heading for the section describing that implementation.

Finally, minor differences in platform implementations are called out in a note, as shown below:



NOTE

This is a note.

Text Conventions

[Table 1](#) and [Table 2](#) list conventions that are used throughout this guide.

Table 1: Notice Icons

Icon	Notice Type	Alerts you to...
	Note	Important features or instructions.
	Caution	Risk of personal injury, system damage, or loss of data.
	Warning	Risk of severe personal injury.

Table 2: Text Conventions

Convention	Description
Screen displays	This typeface indicates command syntax, or represents information as it appears on the screen.
The words “enter” and “type”	When you see the word “enter” in this guide, you must type something, and then press the Return or Enter key. Do not press the Return or Enter key when an instruction simply says “type.”
[Key] names	Key names are written with brackets, such as [Return] or [Esc]. If you must press two or more keys simultaneously, the key names are linked with a plus sign (+). Example: Press [Ctrl]+[Alt]+[Del].
Words in italicized type	Italics emphasize a point or denote new terms at the place where they are defined in the text. (Italics are also used when referring to publication titles.)

Related Publications

The publications related to this one are:

- *ExtremeXOS Command Reference Guide*
- *ExtremeXOS Release Notes*
- *ExtremeXOS Hardware and Software Compatibility Matrix*
- *BlackDiamond 8800 Series Switches Hardware Installation Guide*
- *BlackDiamond X8 Switch Hardware Installation Guide*
- *BlackDiamond 10808 Switch Hardware Installation Guide* (legacy product)
- *BlackDiamond 12800 Series Switches Hardware Installation Guide* (legacy product)
- *BlackDiamond 20800 Series Switches Hardware Installation Guide* (legacy product)
- *Summit Family Switches Hardware Installation Guide*
- *Extreme Networks Pluggable Interface Installation Guide*

Some ExtremeXOS software files have been licensed under certain open source licenses. Information is available on the World Wide Web at the following location:

<http://www.extremenetworks.com/services/osl-exos.aspx>

Documentation for Extreme Networks products is available on the World Wide Web at the following location:

<http://www.extremenetworks.com/>

Using ExtremeXOS Publications Online

You can access ExtremeXOS publications by downloading them from the Extreme Networks World Wide Web location. Publications are provided in Adobe® Portable Document Format (PDF). Displaying or printing PDF files requires that your computer is equipped with Adobe Reader® software, which is available free of charge from Adobe Systems Incorporated.

The Concepts Guide PDF file provides links that connect you directly to relevant command information in the Command Reference Guide PDF file. This quick-referencing capability enables you to easily find

detailed information in the Command Reference Guide for any command mentioned in the Concepts Guide.

To ensure that the quick-referencing feature functions properly:

- 1 Download both the Concepts Guide PDF file and the Command Reference guide PDF file to the *same* destination directory on your computer.
- 2 You may open one or both PDF files. To enable cross-referenced linking between the Concepts Guide and Command Reference guide; however, it is recommended that for ease of use, you keep both files open concurrently on your computer desktop.



NOTE

If you activate a cross-referencing link from the Concepts Guide PDF file to the Command Reference PDF file when the Command Reference PDF file is closed (that is, not currently open on your computer desktop), the system will close the Concepts Guide PDF file and open the Command Reference PDF file. To keep both PDF files open when you activate a cross-reference link, open both PDF files before using the link.

All of these documents are available in Adobe PDF format. You must have Acrobat Reader 5.0 or later to properly open the documents. You must have Acrobat Reader 6.0 or later to use the cross-reference linking feature from the *ExtremeXOS Concepts Guide* to the *ExtremeXOS Command Reference Guide*.



1

PART

Using ExtremeXOS

1 Getting Started

CHAPTER

This chapter includes the following sections:

- [Overview on page 37](#)
- [Software Required on page 39](#)
- [Logging In to the Switch on page 41](#)
- [Understanding the Command Syntax on page 41](#)
- [Port Numbering on page 46](#)
- [Line-Editing Keys on page 48](#)
- [Command History on page 48](#)
- [Common Commands on page 48](#)
- [Accessing the Switch for the First Time on page 51](#)
- [Configuring Management Access on page 52](#)
- [Managing Passwords on page 57](#)
- [Access to Both MSM/MM Console Ports—Modular Switches Only on page 60](#)
- [Domain Name Service Client Services on page 60](#)
- [Checking Basic Connectivity on page 61](#)
- [Displaying Switch Information on page 62](#)

Overview

[Table 3](#) lists the Extreme Networks products that run ExtremeXOS software.

Table 3: ExtremeXOS Switches

Switch Series	Switches
BlackDiamond X8 Series	BlackDiamond X8
BlackDiamond 8800 Series	BlackDiamond 8810 BlackDiamond 8806
Cell Site Routers	E4G-200 E4G-400
Summit X150 Series	Summit X150-24p Summit X150-24t Summit X150-48t

Table 3: ExtremeXOS Switches (Continued)

Switch Series	Switches
Summit X250e Series	Summit X250e-24p Summit X250e-24t Summit X250e-24tDC Summit X250e-24x Summit X250e-24xDC Summit X250e-48p Summit X250e-48t Summit X250e-48tDC
Summit X350 Series	Summit X350-24t Summit X350-48t
Summit X440 Series	Summit X440-8t Summit X440-8p Summit X440-24t Summit X440-24p Summit X440-24t-10G Summit X440-24p-10G Summit X440-48t Summit X440-48p Summit X440-48t-10G Summit X440-48p-10G Summit X440-L2-24t Summit X440-L2-48t
Summit X450a Series	Summit X450a-24t Summit X450a-24tDC Summit X450a-24x Summit X450a-24xDC Summit X450a-48t Summit X450a-48tDC
Summit X450e Series	Summit X450e-24p Summit X450e-24t Summit X450e-48p Summit X450e-48t
Summit X460 Series	Summit X460-24x Summit X460-24t Summit X460-24p Summit X460-48x Summit X460-48t Summit X460-48p
Summit X480 Series	Summit X480-24x Summit X480-48x Summit X480-48t
Summit X650 Series	Summit X650-24t Summit X650-24x
Summit X670	Summit X670-48x Summit X670V-48x
SummitStack	All Summit family switches, except the Summit X150, Summit X350, and Summit X440-L2 series.

Software Required

The tables in this section describe the software version required for each switch that runs ExtremeXOS software.



NOTE

The features available on each switch are determined by the installed feature license and optional feature packs. For more information, see [Appendix A, “Feature License Requirements.”](#)

[Table 4](#) lists the BlackDiamond 8000 series modules and the ExtremeXOS software version required to support each module.

Table 4: BlackDiamond 8000 Series Switch Modules and Required Software

Module Series Name	Modules	Minimum ExtremeXOS Software Version
MSMs	8500-MSM24 MSM-48c 8900-MSM128	ExtremeXOS 12.3 ExtremeXOS 12.1 ExtremeXOS 12.3
c-series	G24Xc G48Xc 10G4Xc 10G8Xc G48Tc S-10G1Xc S-10G2Xc S-G8Xc	ExtremeXOS 12.1 ExtremeXOS 12.1 ExtremeXOS 12.1 ExtremeXOS 12.1 ExtremeXOS 12.1 ExtremeXOS 12.1 ExtremeXOS 12.5.3 ExtremeXOS 12.1
	8900-G96T-c 8900-10G24X-c	ExtremeXOS 12.3
e-series	8500-G24X-e 8500-G48T-e G48Te2	ExtremeXOS 12.3 ExtremeXOS 12.3 ExtremeXOS 12.1
xl-series	8900-G48X-xl 8900-G48T-xl 8900-10G8X-xl	ExtremeXOS 12.4
xm-series	8900-40G6X-xm	ExtremeXOS 12.6

The following guidelines provide additional information on the BlackDiamond 8000 series modules described in [Table 4](#):

- The term *BlackDiamond 8000 series modules* refers to all BlackDiamond 8500, 8800, and 8900 series modules. Beginning with the ExtremeXOS 12.5 release, it does not include other modules formerly listed as *original-series* modules.
- Module names that are not preceded with 8500 or 8900 are BlackDiamond 8800 series modules.
- The *a-series*, *c-series*, *e-series*, *xl-series*, and *xm-series* names are used to distinguish between groups of modules that support different feature sets.

[Table 5](#) lists the Summit family switches that run ExtremeXOS software and the minimum ExtremeXOS software version required.

[Table 5](#) lists the current Summit Family Switches. It does not include the Summit X450 switch that is sometimes referred to as the Summit X450 original switch.

Stacking capable switches are a combination of up to eight Summit family switches (excluding the Summit X150 and the Summit X350 series) that are connected by stacking cables.

Logging In to the Switch

The initial login prompt appears as follows:

```
(Pending-AAA) login:
```

At this point, the failsafe account is now available, but the normal AAA login security is not. (For additional information on using the failsafe account, refer to [“Failsafe Accounts” on page 56.](#))

Wait for the following message to appear:

```
Authentication Service (AAA) on the master node is now available for login.
```

At this point, the normal AAA login security is available. When you now press the [Enter] key, the following prompt appears:

```
login
```

Whether or not you press the [Enter] key, once you see the above message you can perform a normal login. (See [“Default Accounts” on page 55.](#))

Understanding the Command Syntax

This section describes the steps to take when entering a command. Refer to the following sections for detailed information on using the command line interface (CLI).

ExtremeXOS command syntax is described in detail in the *ExtremeXOS Command Reference Guide*. Some commands are also described in this Concepts Guide in order to describe how to use ExtremeXOS software features. However, only a subset of commands are described here, and in some cases only a subset of the options that a command supports. The *ExtremeXOS Command Reference Guide* should be considered the definitive source for information on ExtremeXOS commands.

You may enter configuration commands at the # prompt. At the > prompt, you may enter only monitoring commands, not configuration commands. When you log in as administrator (which has read and write access), you see the # prompt. When you log in as user (which has only read access), you will see the > prompt. As you are booting up, you may see the > command prompt. When the bootup process is complete, the # prompt is displayed.

When entering a command at the prompt, ensure that you have the appropriate privilege level. Most configuration commands require you to have the administrator privilege level. For more information on setting CLI privilege levels, see the *ExtremeXOS Command Reference Guide*. To use the CLI:

- 1 Enter the command name.

If the command does not include a parameter or values, skip to step 3. If the command requires more information, continue to step 2.

- 2 If the command includes a parameter, enter the parameter name and values.

The value part of the command specifies how you want the parameter to be set. Values include numerics, strings, or addresses, depending on the parameter.

- 3 After entering the complete command, press [Enter].

**NOTE**

If an asterisk (*) appears in front of the command line prompt, it indicates that you have pending configuration changes that have not been saved. For more information on saving configuration changes, see [Appendix B, “Software Upgrade and Boot Options.”](#)

This section describes the following topics:

- [Syntax Helper on page 42](#)
- [Object Names on page 42](#)
- [Command Shortcuts on page 45](#)
- [Symbols on page 45](#)
- [Limits on page 46](#)

Syntax Helper

The CLI has a built-in syntax helper. If you are unsure of the complete syntax for a particular command, enter as much of the command as possible, and then press [Tab] or [?]. The syntax helper provides a list of options for the remainder of the command and places the cursor at the end of the command you have entered so far, ready for the next option.

If you enter an invalid command, the syntax helper notifies you of your error and indicates where the error is located.

If the command is one where the next option is a named component (such as a VLAN, access profile, or route map), the syntax helper also lists any currently configured names that might be used as the next option. In situations where this list is very long, the syntax helper lists only one line of names, followed by an ellipsis (...) to indicate that there are more names that can be displayed.

The syntax helper also provides assistance if you have entered an incorrect command.

Object Names

All named components within a category of the switch configuration, such as VLAN, must be given a unique object name. Object names must begin with an alphabetical character and may contain alphanumeric characters and underscores (_), but they cannot contain spaces. The maximum allowed length for a name is 32 characters. User-created object names for the following modules are *not* case-sensitive: access list, account, CFM, EAPS, ESRP, flow-redirect, meter, MSDP, Network Login, PVLAN, protocol, SNMP, SSHD2, STP, tunnel, UPM, VLAN, VMAN, etc.

Object names can be reused across categories (for example, STPD and VLAN names). If the software encounters any ambiguity in the components within your command, it generates a message requesting that you clarify the object you specified.

**NOTE**

If you use the same name across categories, Extreme Networks recommends that you specify the identifying keyword as well as the actual name. If you do not use the keyword, the system may return an error message.

Reserved Keywords

Keywords such as `vlan`, `stp`, and other 2nd level keywords, are determined to be reserved keywords and cannot be used as object names. This restriction applies to the specific word (`vlan`) only, while expanded versions (`vlan2`) can be used.

A complete list of the reserved keywords for ExtremeXOS 12.4.2 and later software is displayed in [Table 6](#). Any keyword that is not on this list can be used as an object name. Prior to 12.4.2, all keywords were reserved, that is, none of them could be used for naming user-created objects such as VLANs.

Table 6: Reserved Keywords

Reserved Keywords				
aaa	elsm	IPv6	pim	sys-health-check
access-list	ems	ipv6acl	policy	syslog
account	epm	irdp	ports	sys-recovery-
accounts	esrp	isid	power	level
all	fabric	isis	primary	tacacs
bandwidth	failover	jumbo-frame	private-vlan	tacacs-
banner	failsafe-	jumbo-frame-size	process	accounting
bfd	account	l2stats	protocol	tacacs-
bgp	fans	l2vpn	put	authorization
bootp	fdb	lacp	gosprofile	tech
bootprelay	fdbentry	learning	gosscheduler	telnet
brm	firmware	learning-domain	radius	telnetd
bvlan	flood-group	license	radius-	temperature
cancel	flooding	license-info	accounting	tftpd
cfgmgr	flow-control	licenses	rip	thttpd
cfm	flow-redirect	lldp	ripng	time
checkpoint-	forwarding	log	rmon	timeout
data	from	loopback-mode	router-	timezone
clear-flow	get	mac	discovery	tos
cli	hal	mac-binding	rtmgr	traffic
cli-config-	hclag	mac-lockdown-	safe-default-	trusted-ports
logging	heartbeat	timeout	script	trusted-servers
clipaging	icmp	management	script	ttnl
configuration	identity-	mcast	secondary	tunnel
configure	management	memory	session	udp
continuous	idletimeout	memorycard	sflow	udp-echo-server
count	idmgr	meter	sharing	udp-profile
counters	igmp	mirroring	show	update
cpu-monitoring	image	mld	slot	upm
cvlan	ingress	mpls	slot-poll-	var
debug	inline-power	mrinfo	interval	version
debug-mode	internal-	msdp	smartredundancy	virtual-router
devmgr	memory	msgsrv	snmp	vlan
dhcp	interval	msm	snmpv3	vman
dhcp-client	job-debug-level	msm-failover	sntp-client	vpls
dhcp-server	iparp	mstp	source	vr
diagnostics	ipconfig	mtrace	ssl	vrrp
diffserv	ipforwarding	multiple-	stacking	watchdog
dns-client	ipmc	response-timeout	stacking-	web
dont-fragment	ipmcforwarding	mvr	support	xmlc
dos-protect	ipmroute	neighbor-	stack-topology	xmlld
dot1ag	ipmtu	discovery	start-size	xml-mode
dot1p	ip-option	netlogin	stp	xml-notification
dot1q	iproute	nettools	stpd	
ds	ip-security	node	subvlan-proxy-	
eaps	ipstats	nodemgr	arp	
edp	ipv4	odometers	svlan	
egress	IPv4	ospf	switch	
elrp	ipv6	ospfv3	switch-mode	
elrp-client				

Abbreviated Syntax

Abbreviated syntax is the shortest unambiguous allowable abbreviation of a command or parameter. Typically, this is the first three letters of the command. If you do not enter enough letters to allow the switch to determine which command you mean, the syntax helper provides a list of the options based on the portion of the command you have entered.



NOTE

When using abbreviated syntax, you must enter enough characters to make the command unambiguous and distinguishable to the switch.

Command Shortcuts

Components are typically named using the `create` command. When you enter a command to configure a named component, you do not need to use the keyword of the component. For example, to create a VLAN, enter a VLAN name:

```
create vlan engineering
```

After you have created the name for the VLAN, you can eliminate the keyword `vlan` from all other commands that require the name to be entered. For example, instead of entering the modular switch command:

```
configure vlan engineering delete port 1:3,4:6
```

you can enter the following shortcut:

```
configure engineering delete port 1:3,4:6
```

Symbols

You may see a variety of symbols shown as part of the command syntax. These symbols explain how to enter the command, and you do not type them as part of the command itself. [Table 7](#) summarizes command syntax symbols.



NOTE

ExtremeXOS software does not support the ampersand (&), left angle bracket (<), or right angle bracket (>), because they are reserved characters with special meaning in XML.

Table 7: Command Syntax Symbols

Symbol	Description
angle brackets < >	Enclose a variable or value. You must specify the variable or value. For example, in the syntax <pre>configure vlan <vlan_name> ipaddress <ipaddress></pre> you must supply a VLAN name for <vlan_name> and an address for <ipaddress> when entering the command. Do not type the angle brackets and do not include spaces within angle brackets.
square brackets []	Enclose a required value or list of required arguments. One or more values or arguments can be specified. For example, in the syntax <pre>disable port [<port_list> all]</pre> you must specify either specific ports or all for all ports when entering the command. Do not type the square brackets.
vertical bar	Separates mutually exclusive items in a list, one of which must be entered. For example, in the syntax <pre>configure snmp add community [readonly readwrite] <alphanumeric_string></pre> you must specify either the read or write community string in the command. Do not type the vertical bar.
braces { }	Enclose an optional value or a list of optional arguments. One or more values or arguments can be specified. For example, in the syntax <pre>reboot {time <month> <day> <year> <hour> <min> <sec>} {cancel} {msm <slot_id>} {slot <slot-number> node-address <node-address> stack-topology {as-standby} }</pre> You can specify either a particular date and time combination, or the keyword <code>cancel</code> to cancel a previously scheduled reboot. (In this command, if you do not specify an argument, the command will prompt, asking if you want to reboot the switch now.) Do not type the braces.

Limits

The command line can process up to 4500 characters, including spaces. If you attempt to enter more than 4500 characters, the switch emits an audible “beep” and will not accept any further input. The first 4500 characters are processed, however.

Port Numbering

The ExtremeXOS software runs on both stand-alone and modular switches, and the port numbering scheme is slightly different on each. This section describes the following topics:

- [Stand-alone Switch Numerical Ranges on page 47](#)
- [Modular Switch and SummitStack Numerical Ranges on page 47](#)
- [Stacking Port Numerical Ranges on page 47](#)



NOTE

The keyword `all` acts on all possible ports; it continues on all ports even if one port in the sequence fails.

Stand-alone Switch Numerical Ranges

On Summit family switches, the port number is simply noted by the physical port number, as shown below:

5

Separate the port numbers by a dash to enter a range of contiguous numbers, and separate the numbers by a comma to enter a range of noncontiguous numbers:

- $x-y$ —Specifies a contiguous series of ports on a stand-alone switch.
- x,y —Specifies a noncontiguous series of ports on a stand-alone switch.
- $x-y,a,d$ —Specifies a contiguous series of ports and a noncontiguous series of ports on a stand-alone switch.

Modular Switch and SummitStack Numerical Ranges

On a modular switch, such as the BlackDiamond 10808 or a SummitStack, the port number is a combination of the slot number and the port number. The nomenclature for the port number is as follows:

`slot:port`

For example, if an I/O module that has a total of four ports is installed in slot 2 of the chassis, the following ports are valid:

- 2:1
- 2:2
- 2:3
- 2:4

You can also use wildcard combinations (*) to specify multiple modular slot and port combinations. The following wildcard combinations are allowed:

- `slot:*`—Specifies all ports on a particular I/O module.
- `slot:x-slot:y`—Specifies a contiguous series of ports on a particular I/O module.
- `slot:x-y`—Specifies a contiguous series of ports on a particular I/O module.
- `slota:x-slotb:y`—Specifies a contiguous series of ports that begin on one I/O module or SummitStack node and end on another node.

Stacking Port Numerical Ranges

On a SummitStack, a stacking port number is a combination of the slot number and the stacking port number shown near the connector on the back of the Summit family switch:

`slot:port`

These numbers are context-specific. For example, while the front-panel port 2:1 on a Summit X450a-24t is a 10/100/1000 Ethernet port, the stacking port 2:1 is a 10Gb port on the rear panel of the X450a-24t that has been marked as "Stacking Port 1". When no context is given, port 2:1 refers to a front-panel port on the Summit family switch (the 10Gb ports on, for example, a XGM2-2xn option card are considered front-panel ports in this context).

The use of wildcards and ranges for stacking ports is the same as described in "Modular Switch and SummitStack Numerical Ranges".

Line-Editing Keys

Table 8 describes the line-editing keys available using the CLI.

Table 8: Line-Editing Keys

Key(s)	Description
Left arrow or [Ctrl] + B	Moves the cursor one character to the left.
Right arrow or [Ctrl] + F	Moves the cursor one character to the right.
[Ctrl] + H or Backspace	Deletes character to left of cursor and shifts remainder of line to left.
Delete or [Ctrl] + D	Deletes character under cursor and shifts remainder of line to left.
[Ctrl] + K	Deletes characters from under cursor to end of line.
Insert	Toggles on and off. When toggled on, inserts text and shifts previous text to right.
[Ctrl] + A	Moves cursor to first character in line.
[Ctrl] + E	Moves cursor to last character in line.
[Ctrl] + L	Clears screen and moves cursor to beginning of line.
[Ctrl] + P or Up Arrow	Displays previous command in command history buffer and places cursor at end of command.
[Ctrl] + N or Down Arrow	Displays next command in command history buffer and places cursor at end of command.
[Ctrl] + U	Clears all characters typed from cursor to beginning of line.
[Ctrl] + W	Deletes previous word.
[Ctrl] + C	Interrupts the current CLI command execution.

Command History

The ExtremeXOS software stores the commands you enter. You can display a list of these commands by using the following command:

```
history
```

Common Commands

Table 9 describes some of the common commands used to manage the switch. Commands specific to a particular feature may also be described in other chapters of this guide. For a detailed description of the commands and their options, see the *ExtremeXOS Command Reference Guide*.

Table 9: Common Commands

Command	Description
<code>clear session [history <sessId> all]</code>	Terminates a Telnet or SSH2 session from the switch.
<code>configure account [all <name>]</code>	Configures a user account password. Passwords can have a minimum of 0 character and can have a maximum of 32 characters. Passwords are case-sensitive. User names are not case-sensitive.

Table 9: Common Commands (Continued)

Command	Description
<code>configure banner { after-login { before-login } { acknowledge } before-login {acknowledge} save-to-configuration}</code>	Configures the banner string. You can configure a banner to be displayed before login or after login. You can enter up to 24 rows of 79-column text that is displayed before the login prompt of each session.
<code>configure ports <port_list> {medium [copper fiber]} auto off speed <speed> duplex [half full]</code>	Manually configures the port speed and duplex setting of one or more ports on a switch.
<code>configure slot <slot> module <module_type></code>	Configures a slot for a particular I/O module card. NOTE: This command is available only on modular switches.
<code>configure ssh2 key {pregenerated}</code>	Generates the SSH2 host key. You must install the SSH software module in addition to the base image to run SSH.
<code>configure sys-recovery-level [all none]</code>	Configures a recovery option for instances where an exception occurs in ExtremeXOS software.
<code>configure time <month> <day> <year> <hour> <min> <sec></code>	Configures the system date and time. The format is as follows: mm dd yyyy hh mm ss The time uses a 24-hour clock format. You cannot set the year earlier than 2003 or past 2036.
<code>configure timezone {name <tz_name>} <GMT_offset> {autodst {name <dst_timezone_ID>} {<dst_offset>} {begins [every <floatingday> on <absoluteday>} {at <time_of_day>} {ends [every <floatingday> on <absoluteday>} {at <time_of_day>}} } noautodst}</code>	Configures the time zone information to the configured offset from GMT time. The format of <code>GMT_offset</code> is +/- minutes from GMT time. The <code>autodst</code> and <code>noautodst</code> options enable and disable automatic Daylight Saving Time change based on the North American standard. Additional options are described in the <i>ExtremeXOS Command Reference Guide</i> .
<code>configure {vlan} <vlan_name> ipaddress [<ipaddress> {<ipNetmask>} ipv6-link-local {eui64} <ipv6_address_mask>]</code>	Configures an IP address and subnet mask for a VLAN.
<code>create account [admin user] <account-name> {encrypted <password>}</code>	Creates a user account. This command is available to admin-level users and to users with RADIUS command authorization. The username is between 1 and 32 characters and is not case-sensitive. The password is between 0 and 32 characters and is case-sensitive.
<code>create vlan <vlan_name> {description <vlan-description>} {vr <name>}</code>	Creates a VLAN.
<code>delete account <name></code>	Deletes a user account.
<code>delete vlan <vlan_name></code>	Deletes a VLAN.
<code>disable bootp vlan [<vlan> all]</code>	Disables BOOTP for one or more VLANs.
<code>disable cli prompting</code>	Disables CLI prompting for the session.
<code>disable cli-config-logging</code>	Disables logging of CLI commands to the Syslog.
<code>disable clipaging</code>	Disables pausing of the screen display when a show command output reaches the end of the page.
<code>disable idletimeout</code>	Disables the timer that disconnects all sessions. After being disabled, console sessions remain open until the switch is rebooted or until you log off. Telnet sessions remain open until you close the Telnet client. SSH2 sessions time out after 61 minutes of inactivity.

Table 9: Common Commands (Continued)

Command	Description
<pre>disable port [<port_list> all] disable ssh2</pre>	<p>Disables one or more ports on the switch.</p> <p>Disables SSH2 Telnet access to the switch.</p> <p>You must install the SSH2 software module in addition to the base image to run SSH.</p>
<pre>disable telnet</pre>	<p>Disables Telnet access to the switch.</p>
<pre>enable bootp vlan [<vlan> all] enable cli-config-logging</pre>	<p>Enables BOOTP for one or more VLANs.</p> <p>Enables the logging of CLI configuration commands to the Syslog for auditing purposes. The default setting is enabled.</p>
<pre>enable clipaging</pre>	<p>Enables pausing of the screen display when <code>show</code> command output reaches the end of the page. The default setting is enabled.</p>
<pre>enable idletimeout</pre>	<p>Enables a timer that disconnects all sessions (Telnet, SSH2, and console) after 20 minutes of inactivity. The default setting is enabled.</p>
<pre>enable license {software} <key></pre>	<p>Enables a particular software feature license. Specify <code><license_key></code> as an integer.</p> <p>The command <code>unconfigure switch {all}</code> does not clear licensing information. This license cannot be disabled once it is enabled on the switch.</p>
<pre>enable ssh2 {access-profile [<access_profile> none]} {port <tcp_port_number>} {vr [<vr_name> all default]}</pre>	<p>Enables SSH2 sessions. By default, SSH2 is disabled. When enabled, SSH2 uses TCP port number 22.</p> <p>You must install the SSH2 software module in addition to the base image to run SSH.</p>
<pre>enable telnet</pre>	<p>Enables Telnet access to the switch. By default, Telnet uses TCP port number 23.</p>
<pre>history</pre>	<p>Displays the commands entered on the switch.</p>
<pre>show banner { after-login before- login }</pre>	<p>Displays the user-configured banner.</p>
<pre>unconfigure switch {all}</pre>	<p>Resets all switch parameters (with the exception of defined user accounts, and date and time information) to the factory defaults.</p> <p>If you specify the keyword <code>all</code>, the switch erases the currently selected configuration image in flash memory and reboots. As a result, all parameters are reset to default settings.</p>

Accessing the Switch for the First Time

When you take your switch from the box and set it up for the first time, you must connect to the console to access the switch. You are prompted with an interactive script that specifically asks if you want to disable Telnet and SNMP, so that these will not be available on your switch at next reboot. This is called the *safe defaults* mode.

After you connect to the console and log in to the switch, the screen displays several interactive questions that lead you through configuring management access. You disable SNMP, or Telnet access by using the interactive script (refer to “[Safe Defaults Setup Method](#)” on page 51).

All ports are enabled in the factory default setting; you can choose to have all unconfigured ports disabled on reboot using the interactive questions.

In addition, you can return to the safe defaults mode by issuing the following commands:

- `unconfigure switch {all}`
- `configure safe-default-script`

Safe Defaults Setup Method

After you connect to the console port of the switch, or after you issue the `unconfigure switch {all}` or `configure safe-default-script` CLI command, the system returns the following interactive script:

```
This switch currently has all management methods enabled for convenience reasons.  
Please answer these questions about the security settings you would like to use.
```

```
Telnet is enabled by default. Telnet is unencrypted and has been the target of  
security exploits in the past.
```

```
Would you like to disable Telnet? [y/N]:
```

```
SNMP access is enabled by default. SNMP uses no encryption, SNMPv3 can be  
configured to eliminate this problem.
```

```
Would you like to disable SNMP? [y/N]:
```

```
All ports are enabled by default. In some secure applications, it maybe more  
desirable for the ports to be turned off.
```

```
Would you like unconfigured ports to be turned off by default? [y/N]:
```

```
Changing the default failsafe account username and password is highly  
recommended. If you choose to do so, please remember the username and  
password as this information cannot be recovered by Extreme Networks.  
Would you like to change the failsafe account username and password  
now? [y/N]:
```

```
Would you like to permit failsafe account access via the management port?  
[y/N]:
```

```
Since you have chosen less secure management methods, please remember to  
increase the security of your network by taking the following actions:
```

- * change your admin password
- * change your failsafe account username and password

- * change your SNMP public and private strings
- * consider using SNMPv3 to secure network management traffic

You see this interactive script *only* under the following conditions:

- At initial login (when you use the switch the first time)
- After the command `unconfigure switch {all}`
- After the command `configure safe-default-script`

All the changes made using this interactive script can be saved through switch reboots, if you save the setting. If you want to change the management access:

- Use the `configure safe-default-script` command to maintain your configuration and rerun the script.
- Use the `unconfigure switch {all}` command to reset your switch to the default factory setting and rerun the script.

Configuring Management Access

This section discusses the following topics:

- [Account Access Levels on page 52](#)
- [Configuring Banners on page 53](#)
- [Startup Screen and Prompt Text on page 54](#)
- [Default Accounts on page 55](#)
- [Creating a Management Account on page 56](#)
- [Failsafe Accounts on page 56](#)

Account Access Levels

ExtremeXOS software supports the following two levels of management:

- User
- Administrator

In addition to the management levels, you can optionally use an external RADIUS server to provide CLI command authorization checking for each command. For more information on RADIUS, see [Chapter 23, “Security.”](#)

User Account

A user-level account has viewing access to all manageable parameters, with the exception of:

- User account database
- SNMP community strings

A person with a user-level account can use the `ping` command to test device reachability and change the password assigned to the account name. If you have logged on with user capabilities, the command line prompt ends with a (>) sign. For example:

```
BD-1.2 >
```

Administrator Account

A person with an administrator-level account can view and change all switch parameters. With this level, you can also add and delete users, as well as change the password associated with any account name (to erase the password, use the `unconfigure switch all` command).

The administrator can disconnect a management session that has been established by way of a Telnet connection. If this happens, the user logged on by way of the Telnet connection is notified that the session has been terminated.

If you have logged on with administrator capabilities, the command line prompt ends with a (#) sign. For example:

```
BD-1.18 #
```

Configuring Banners

You can configure the following types of CLI session banners:

- A banner for a session that displays before login.
- A banner for a session that displays after login.

To add a banner to your switch, use the following command:

```
configure banner { after-login | { before-login } { acknowledge } | before-login
{acknowledge} save-to-configuration}
```

The following applies to the use of the optional parameters:

- When no optional parameters are specified, the command configures a banner for a CLI session that displays before login.
- A CLI banner can have a maximum size of 24 rows with 79 columns of text.
- When the `acknowledge` parameter is specified, you must hit a key to get the login prompt.

To clear a configured banner, use the following command:

```
unconfigure banner { after-login | before-login }
```

To disable the acknowledgement feature, which forces the user to press a key before the login screen displays, use the `configure banner` command omitting the `acknowledge` parameter.

To display the banners that are configured on the switch, use the following command:

```
show banner { after-login | before-login }
```



NOTE

In addition to CLI banners described here, you can also configure network login banners. For information, see “Configuring the Login Page” on page 788 in the Network Login chapter.

Startup Screen and Prompt Text

Once you log into the switch, the system displays the startup screen, as follows:

```
login: admin
password: blue7

ExtremeXOS
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Protected by US Patent Nos: 6,678,248; 6,104,700; 6,766,482; 6,618,388; 6,034,957;
 6,859,438; 6,912,592; 6,954,436; 6,977,891; 6,980,550; 6,981,174; 7,003,705; 7,01
2,082.
=====

Press the <tab> or '?' key at any time for completions.
Remember to save your configuration changes.

* <switchname>.1 #
```

You must have an administrator-level account to change the text of the prompt. The prompt text is taken from the SNMP `sysname` setting.

The number that follows the period after the switch name indicates the sequential line of the specific command or line for this CLI session.

If an asterisk (*) appears in front of the command line prompt, it indicates that you have outstanding configuration changes that have not been saved. For example:

```
* BD-1.19 #
```

If you have logged on with administrator capabilities, the command line prompt ends with a (#) sign. For example:

```
BD-1.18 #
```

If you have logged on with user capabilities, the command line prompt ends with a (>) sign. For example:

```
BD-1.2 >
```

Using the system recovery commands (refer to [Chapter 11, “Status Monitoring and Statistics,”](#) for information on system recovery), you can configure either one or more specified slots on a modular switch or the entire stand-alone switch to shut down in case of an error. If you have configured this feature and a hardware error is detected, the system displays an explanatory message on the startup screen. The message is slightly different, depending on whether you are working on a modular switch or a stand-alone switch.

The following sample shows the startup screen if any of the slots in a modular switch are shut down as a result of the system recovery configuration:

```
login: admin
password:

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 6,859,438; 6,912,592; 6,954,436; 6,977,891; 6,980,550; 6,981,174; 7,003,705; 7,01
2,082.
=====
```

Press the <tab> or '?' key at any time for completions.
Remember to save your configuration changes.

**The I/O modules in the following slots are shut down: 1,3
Use the "clear sys-recovery-level" command to restore I/O modules**

```
! BD-8810.1 #
```

When an exclamation point (!) appears in front of the command line prompt, it indicates that one or more slots or the entire stand-alone switch are shut down as a result of your system recovery configuration and a switch error. (Refer to [Chapter 11, "Status Monitoring and Statistics,"](#) for complete information on system recovery and system health check features.)

The following sample shows the startup screen if a stand-alone switch is shut down as a result of the system recovery configuration:

```
login: admin
password:
```

```
ExtremeXOS
```

```
Copyright (C) 2000-2006 Extreme Networks. All rights reserved.
```

```
Protected by US Patent Nos: 6,678,248; 6,104,700; 6,766,482; 6,618,388; 6,034,957;
6,859,438; 6,912,592; 6,954,436; 6,977,891; 6,980,550; 6,981,174; 7,003,705; 7,01
2,082.
```

```
=====
```

Press the <tab> or '?' key at any time for completions.
Remember to save your configuration changes.

**All switch ports have been shut down.
Use the "clear sys-recovery-level" command to restore all ports.**

```
! SummitX450-24x.1 #
```

Default Accounts

By default, the switch is configured with two accounts, as shown in [Table 10](#).

Table 10: Default Accounts

Account Name	Access Level
admin	This user can access and change all manageable parameters. However, the user may not delete all admin accounts.
user	This user can view (but not change) all manageable parameters, with the following exceptions: <ul style="list-style-type: none"> This user cannot view the user account database. This user cannot view the SNMP community strings.

To change the password on the default account, see ["Applying a Password to the Default Account" on page 58](#).

Creating a Management Account

The switch can have a total of 16 management accounts. You can use the default names (*admin* and *user*), or you can create new names and passwords for the accounts. Passwords can have a minimum of 0 characters and a maximum of 32 characters.

To create a new account:

- 1 Log in to the switch as *admin*.
- 2 At the password prompt, press [Enter], or enter the password that you have configured for the *admin* account.
- 3 Add a new user by using the following command:

```
create account [admin | user] <account-name> {encrypted <password>}
```

If you do not specify a password or the keyword “encrypted”, you are prompted for one. Passwords are case-sensitive.

If you do not want a password associated with the specified account, press [Enter] twice.

User-created account names are not case-sensitive.

Viewing Accounts

To view the accounts that have been created, you must have administrator privileges. To see the accounts, use the following command:

```
show accounts
```

Deleting an Account

To delete an account, you must have administrator privileges. To delete an account, use the following command:

```
delete account <name>
```

Failsafe Accounts

The failsafe account is the account of last resort to access your switch. This account is never displayed by the `show accounts` command, but it is always present on the switch. To display whether the user configured a username and password for the failsafe account or to show the configured connection-type access restrictions use the following command:

```
show failsafe-account
```

The failsafe account has *admin* access level. To configure the account name and password for the failsafe account, use the following command:

```
configure failsafe-account {[deny | permit] [all | control | serial | ssh {vr <vr-name>} | telnet {vr <vr-name>}]}
```

When you use the command with no parameters, you are prompted for the failsafe account name and prompted twice to specify the password for the account. For example:

```
BD-10808.1 # configure failsafe-account
enter failsafe user name: blue5green
enter failsafe password:
enter password again:
BD-10808.2
```

When you use the command with the `permit` or `deny` parameter, the connection-type access restrictions are altered as specified. For example:

```
BD-8810.1 # configure failsafe-account deny all
BD-8810.2 # configure failsafe-account permit serial
```

The failsafe account is immediately saved to NVRAM. On a modular switch, the failsafe account is saved to both MSM/MMs' NVRAMs if both are present. On a SummitStack, the failsafe account is saved in the NVRAM of every node in the active topology.



NOTE

On a SummitStack, when the `synchronize stacking {node-address <node-address> | slot <slot-number>}` command is used, the failsafe account is transferred from the current node to the specified nodes in the stack topology.

You need not provide the existing failsafe account information to change it.



NOTE

The information that you use to configure the failsafe account cannot be recovered by Extreme Networks. Technical support cannot retrieve passwords or account names for this account. Protect this information carefully.

To access your switch using the failsafe account:

- 1 Connect to the switch using one of the (configured) permitted connection types.
- 2 At the switch login prompt, carefully enter the failsafe account name. If you enter an erroneous account name, you cannot re-enter the correct name. In that case, press [Enter] until you get a login prompt and then try again.
- 3 When prompted, enter the password.

Managing Passwords

When you first access the switch, you have a default account. You configure a password for your default account. As you create other accounts (see [“Creating a Management Account” on page 56](#)), you configure passwords for those accounts.

The software allows you to apply additional security to the passwords. You can enforce a specific format and minimum length for the password. Additionally, you can age out the password, prevent a user from employing a previously used password, and lock users out of the account after three consecutive failed login attempts.

You can change the password to an encrypted password after you create an account.

This section describes the following topics:

- [Applying a Password to the Default Account on page 58](#)
- [Applying Security to Passwords on page 58](#)
- [Displaying Passwords on page 59](#)

Applying a Password to the Default Account

Default accounts do not have passwords assigned to them. Passwords can have a minimum of 0 and a maximum of 32 characters. (If you specify the format of passwords using the `configure account password-policy char-validation` command, the minimum is 8 characters.)

**NOTE**

Passwords are case-sensitive. User-created account names are not case-sensitive.

To add a password to the default admin account:

- 1 Log in to the switch using the name *admin*.
- 2 At the password prompt, press [Enter].
- 3 Add a default admin password of *green* by entering the following command:

```
configure account admin green
```

To add a password to the default user account:

- 1 Log in to the switch using the name *user*.
- 2 At the password prompt, press [Enter], or enter the password that you have configured for the *user* account.
- 3 Add a default user password of *blue* by entering the following command:

```
configure account user blue
```

**NOTE**

If you forget your password while logged out of the CLI, you can use the bootloader to reinstall a default switch configuration, which allows access to the switch without a password. Note that this process reconfigures all switch settings back to the initial default configuration.

Applying Security to Passwords

You can increase the security of your system by enforcing password restrictions, which will make it more difficult for unauthorized users to access your system.

You can specify that each password must include at least *two* characters of each of the following four character types:

- Upper-case A-Z
- Lower-case a-z
- 0-9
- !, @, #, \$, %, ^, *, (,)

To set this format for the password, use the following command:

```
configure account [all | <name>] password-policy char-validation [none | all-char-groups]
```

You can enforce a minimum length for the password and set a maximum time limit, after which the password will not be accepted.

To set a minimum length for the password, use the following command:

```
configure account [all | <name>] password-policy min-length [<num_characters> | none]
```

To age out the password after a specified time, use the following command:

```
configure account [all | <name>] password-policy max-age [<num_days> | none]
```

You can block users from employing previously used passwords by issuing the command:

```
configure account [all | <name>] password-policy history [<num_passwords> | none]
```

By default, the system terminates a session after the user has three consecutive failed login attempts. The user may then launch another session (which would also terminate after three consecutive failed login attempts). To increase security, you can lock users out of the system entirely after three failed consecutive login attempts. To use this feature, use the following command:

```
configure account [all | <name>] password-policy lockout-on-login-failures [on | off]
```

**NOTE**

If you are not working on SSH, you can configure the number of failed logins that trigger lockout, using the `configure cli max-failed-logins <num-of-logins>` command. (This command also sets the number of failed logins that terminate the particular session.)

After the user's account is locked out (using the `configure account password-policy lockout-on-login-failures` command), it must be re-enabled by an administrator. To re-enable a locked-out account, use the following command:

```
clear account [all | <name>] lockout
```

Selecting the `all` option affects the setting of all existing and future new accounts.

**NOTE**

The default admin account and failsafe accounts are never locked out, no matter how many consecutive failed login attempts.

Displaying Passwords

To display the accounts and any applied password security, use the following command:

```
show accounts password-policy
```

You can also display which accounts may be locked out by issuing the following command:

```
show accounts
```

Access to Both MSM/MM Console Ports—Modular Switches Only

You can access either the primary or the backup MSM/MM regardless of which console port you are connected to.

Use the following command:

```
telnet msm [a | b]
```

Access to an Active Node in a SummitStack

You can access any active node in a SummitStack from any other active node in the active topology. Use the following command:

```
telnet slot <slot-number>
```

Domain Name Service Client Services

The Domain Name Service (DNS) client in ExtremeXOS software augments the following commands to allow them to accept either IP addresses or host names:

- `telnet`
- `download bootrom`
- `download image`
- `ping`
- `traceroute`
- `configure radius server client-ip`
- `configure tacacs server client-ip`
- `create cfm domain dns md-level`

The DNS client can resolve host names to both IPv4 and IPv6 addresses.

In addition, the `nslookup` utility can be used to return the IP address of a host name.

You can specify up to eight DNS servers for use by the DNS client using the following command:

```
configure dns-client add
```

You can specify a default domain for use when a host name is used without a domain. Use the following command:

```
configure dns-client default-domain
```

For example, if you specify the domain `xyz-inc.com` as the default domain, then a command such as `ping accounting1` will be taken as if it had been entered `ping accounting1.xyz-inc.com`.

Checking Basic Connectivity

The switch offers the following commands for checking basic connectivity:

- ping
- traceroute

Ping

The `ping` command enables you to send Internet Control Message Protocol (ICMP) echo messages to a remote IP device. The `ping` command is available for both the user and administrator privilege levels.

The `ping` command syntax is:

```
ping {count <count> {start-size <start-size> | continuous {start-size <start-size> |
{start-size <start-size> {end-size <end-size>}}} {udp} {dont-fragment} {ttl <ttl>}
{tos <tos>} {interval <interval>} {vr <vrid>} {ipv4 <host> | ipv6 <host>} {from} {with
record-route}
```

Options for the ping command are described in [Table 11](#).

Table 11: Ping Command Parameters

Parameter	Description
count	Specifies the number of ping requests to send.
start-size	Specifies the size, in bytes, of the packet to be sent, or the starting size if incremental packets are to be sent.
continuous	Specifies that UDP or ICMP echo messages are to be sent continuously. This option can be interrupted by pressing [Ctrl] + C.
end-size	Specifies an end size for packets to be sent.
udp	Specifies that the ping request should use UDP instead of ICMP.
dont-fragment	Sets the IP to not fragment the bit.
ttl	Sets the TTL value.
tos	Sets the TOS value.
interval	Sets the time interval between sending out ping requests.
vr	Specifies the virtual router name to use for sending out the echo message. If not specified, <i>VR-Default</i> is used. NOTE: User-created VRs are supported only on the platforms listed for this feature in Appendix A, "Feature License Requirements."
ipv4	Specifies IPv4 transport.
ipv6	Specifies IPv6 transport. NOTE: If you are contacting an IPv6 link local address, you must specify the VLAN you are sending the message from: <code>ping <ipv6> <link-local address> %<vlan_name> <host></code> .
host	Specifies a host name or IP address (either v4 or v6).
from	Uses the specified source address. If not specified, the address of the transmitting interface is used.
with record-route	Sets the traceroute information.

If a `ping` request fails, the switch stops sending the request after three attempts. Press [Ctrl] + C to interrupt a `ping` request earlier. The statistics are tabulated after the ping is interrupted or stops.

Use the `ipv6` variable to ping an IPv6 host by generating an ICMPv6 echo request message and sending the message to the specified address. If you are contacting an IPv6 link local address, you must specify the VLAN that you are sending the message from, as shown in the following example (you must include the % sign): `ping <ipv6> <link-local address> %<vlan_name> <host>`.

Traceroute

The `traceroute` command enables you to trace the path between the switch and a destination endstation. The `traceroute` command syntax is:

```
traceroute {vr <vrid>} {ipv4 <host>} {ipv6 <host>} {ttl <number>} {from <from>} {[port <port>] | icmp}
```

Where:

- `vr` is the name of the virtual router.
- `ipv4/ipv6` is the transport.
- `from` uses the specified source address in the ICMP packet. If not specified, the address of the transmitting interface is used.
- `host` is the host of the destination endstation. To use the hostname, you must first configure DNS.
- `ttl` configures the switch to trace the hops until the time-to-live has been exceeded for the switch.
- `port` uses the specified UDP port number.
- `icmp` uses ICMP echo messages to trace the routed path.

Displaying Switch Information

To display basic information about the switch, use the following command:

```
show switch
```

To display other switch related information, refer to the “Alphabetical List of Standard Commands” in the *ExtremeXOS Command Reference Guide*.

Filtering the Output of Show Commands

The output from many `show` commands can be long and complicated, sometimes containing more information than you need at a given time. The filter output display feature allows you to extract the output information from a `show` command that fits your needs.

The feature is a restricted version of a UNIX/Linux feature that uses a “pipe” character to direct the output of one command to be used as input for the next command. It provides support for “piping” `show` command output to the display filter using the vertical bar (|) operator. (In the following command, it is the first vertical bar.) The display filter displays the output based on the specified filter keyword option and the text pattern entered. By selecting different filter options you can include or

exclude all output that matches the pattern. You can also exclude all output until a line matches the pattern and then include all output beginning with that line.

In ExtremeXOS software, the resulting command is as follows:

```
show <specific show command syntax> | {include | exclude | begin} <regexp>
```

The following describes the command syntax:

show <specific show command syntax>	State the command. For example: <code>show ports</code> . (This is followed by the vertical bar () when used as the pipe character.)
include	Display the lines that match the regular expression.
exclude	Do not display the lines that match the regular expression.
begin	Display all the lines starting with the first line that matches the regular expression.
regexp	The regular expression to match. <ul style="list-style-type: none"> • Regular expressions are case-sensitive. • Special characters in regular expressions such as [], ?, and * have special significance to the Linux shell and it is therefore common to specify your regular expression in quotes to protect it from the shell. • A summary of special characters is shown in Table 12.

For example, to display the status of “flow control” on the ports of a BlackDiamond 8810 switch, use the following command:

```
show ports 2:1-2 information detail | include "(Port|Flow Control)"
```

The output would resemble the following:

```
Port: 2:1
    Flow Control:   Rx-Pause: Enabled      Tx-Pause: Disabled
    Priority Flow Control: Disabled
Port: 2:2
    Flow Control:   Rx-Pause: Enabled      Tx-Pause: Disabled
    Priority Flow Control: Disabled
```

If the specified `show` command outputs a refreshed display, using the output display filter terminates the display without refreshing and a message is displayed to that effect.

This command is supported on most of the ExtremeXOS `show` commands. A few commands, for example, `show tech`, are not implemented in such a way as to make piping (filtering) possible.

[Table 12](#) shows a summary of special characters.

Table 12: Definition of Regular Expression Characters

Operator Type	Examples	Description
Literal Characters Match a character exactly	a A y 6 % @	Letters, digits and many special characters match exactly
	\\$ \^ \+ \ \?	Precede other special characters with a \ to cancel their regex special meaning
	\n \t \r	Literal new line, tab, return

Table 12: Definition of Regular Expression Characters (Continued)

Operator Type	Examples	Description
Anchors and assertions	^ \$	Starts with Ends with
Character groups any 1 character from the group	[aAeEiou] [^aAeEiou] [a-fA-F0-9]	any character listed from [to] any character except aAeEio or u any hex character (0 to 9 or a to f)
Counts apply to previous element	. + * ?	any character at all 1 or more ("some") 0 or more ("perhaps some") 0 or 1 ("perhaps a")
Alternation		either, or

2

CHAPTER

Managing the Switch

This chapter includes the following sections:

- [Overview on page 65](#)
- [Understanding the ExtremeXOS Shell on page 66](#)
- [Using the Console Interface on page 66](#)
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Overview

Using ExtremeXOS, you can manage the switch using the following methods:

- Access the command line interface (CLI) by connecting a terminal (or workstation with terminal-emulation software) to the console port.
- Access the switch remotely using TCP/IP through one of the switch ports or through the dedicated 10/100 unshielded twisted pair (UTP) Ethernet management port. Remote access includes:
 - Telnet using the CLI interface.
 - Secure Shell (SSH2) using the CLI interface.

- Simple Network Management Protocol (SNMP) access using Ridgeline® or another SNMP manager.
- Download software updates and upgrades. For more information, see [Appendix B, “Software Upgrade and Boot Options.”](#)

The switch supports up to the following number of concurrent user sessions:

- One console session—Two console sessions are available if two management modules are installed.
- Eight shell sessions
- Eight Telnet sessions
- Eight Trivial File Transfer Protocol (TFTP) sessions
- Eight SSH2 sessions

Understanding the ExtremeXOS Shell

When you log in to ExtremeXOS from a terminal, a shell prompt is displayed. At the prompt, input the commands to be executed on the switch. After the switch processes and executes a command, the results are relayed to and displayed on your terminal.

The shell supports ANSI, VT100, and XTERM terminal emulation and adjusts to the correct terminal type and window size. In addition, the shell supports UNIX-style page view for page-by-page command output capability.

By default, up to eight active shell sessions can access the switch concurrently; however, you can change the number of simultaneous, active shell sessions supported by the switch. You can configure up to 16 active shell sessions. Configurable shell sessions include both Telnet and SSH connections (not console CLI connections). If only eight active shell sessions can access the switch, a combination of eight Telnet and SSH connections can access the switch even though Telnet and SSH each support eight connections. For example, if you have six Telnet sessions and two SSH sessions, no one else can access the switch until a connection is terminated or you access the switch via the console.

If you configure a new limit, only new incoming shell sessions are affected. If you decrease the limit and the current number of sessions already exceeds the new maximum, the switch refuses only new incoming connections until the number of shell session drops below the new limit. Already connected shell sessions are not disconnected as a result of decreasing the limit.

To configure the number of shell sessions accepted by the switch, use the following command:

```
configure cli max-sessions
```

For more information about the line-editing keys that you can use with the XOS shell, see [“Line-Editing Keys” on page 48](#).

Using the Console Interface

The CLI built into the switch is accessible via:

- BlackDiamond X8 series: RJ-45 port for use with a rollover cable
- BlackDiamond 8800 series and all Summit switches: 9-pin, RS-232 ports.

On a modular switch, the console port is located on the front of the management module (MSM/MM). On a stand-alone switch, the console port is located on the front panel.

**NOTE**

For more information on the console port pinouts, see the hardware installation guide that shipped with your switch.

After the connection has been established, you see the switch prompt and you can log in.

Using the 10/100 Ethernet Management Port

The management module or Summit family switches provide a dedicated 10/100 Mbps or 10/100/1000 Mbps Ethernet management port. This port provides dedicated remote access to the switch using TCP/IP. It supports the following management methods:

- Telnet/SSH2 using the CLI interface
- SNMP access using Ridgeline or another SNMP manager

The switch uses the Ethernet management port only for host operation, not for switching or routing. The TCP/IP configuration for the management port is done using the same syntax as used for virtual LAN (VLAN) configuration. The VLAN *mgmt* comes preconfigured with only the management port as a member. The management port is a member of the virtual router *VR-Mgmt*.

When you configure the IP address for the VLAN *mgmt*, this address gets assigned to the primary MSM/MM. You can connect to the management port on the primary MSM/MM for any switch configuration. The management port on the backup MSM/MM is available only when failover occurs. At that time, the primary MSM/MM relinquishes its role, the backup MSM/MM takes over, and the VLAN *mgmt* on the new primary MSM/MM acquires the IP address of the previous primary MSM/MM.

To configure the IP address and subnet mask for the VLAN *mgmt*, use the following command:

```
configure vlan mgmt ipaddress <ip_address>/<subnet_mask>
```

To configure the default gateway (you must specify *VR-Mgmt* for the management port and VLAN *mgmt*), use the following command:

```
configure iproute add default <gateway> {<metric>} {multicast | multicast-only | unicast | unicast-only} {vr <vrname>}
```

The following example configuration sets the management port IP address to 192.168.1.50, mask length of 25, and configures the gateway to use 192.168.1.1:

```
configure vlan mgmt ipaddress 192.168.1.50/25
configure iproute add default 192.168.1.1 vr vr-mgmt
```

On a SummitStack, the master node is accessed using the management port *primary* IP address as shown above for other platforms. The primary IP address is acquired by the backup node when it becomes the master node due to a failover. You can also directly access any node in the stack using its *alternate* IP address if the node's management port is connected to your network. For more information see “[Logging into a Stack](#)” on page 153.

Using Ridgeline to Manage the Network

Ridgeline is a powerful yet easy-to-use application suite that facilitates the management of a network of Extreme Networks switches, as well as selected third-party switches. Ridgeline offers a comprehensive set of network management tools that are easy to use from a client workstation running Ridgeline client software, or from a workstation configured with a web browser and the Java plug-in.

For more information about the Ridgeline management software available from Extreme Networks, go to: <http://www.extremenetworks.com>.

To review the Ridgeline documentation, go to: <http://www.extremenetworks.com/services/software-userguide.aspx>.

Authenticating Users

ExtremeXOS provides three methods to authenticate users who log in to the switch:

- RADIUS client
- TACACS+
- Local database of accounts and passwords



NOTE

You cannot configure RADIUS and TACACS+ at the same time.

RADIUS Client

Remote Authentication Dial In User Service (RADIUS, RFC 2138) is a mechanism for authenticating and centrally administrating access to network nodes. The ExtremeXOS RADIUS client implementation allows authentication for Telnet or console access to the switch.

For detailed information about RADIUS and configuring a RADIUS client, see [Chapter 23, “Security.”](#)

TACACS+

Terminal Access Controller Access Control System Plus (TACACS+) is a mechanism for providing authentication, authorization, and accounting on a central server, similar in function to the RADIUS client. The ExtremeXOS version of TACACS+ is used to authenticate prospective users who are attempting to administer the switch. TACACS+ is used to communicate between the switch and an authentication database.

For detailed information about TACACS+ and configuring TACACS+, see [Chapter 23, “Security.”](#)

Management Accounts

ExtremeXOS supports two levels of management accounts (local database of accounts and passwords): User and Administrator. A user level account can view but not change all manageable parameters, with

the exception of the user account database and SNMP community strings. An administrator level account can view and change all manageable parameters.

For detailed information about configuring management accounts, see [Chapter 1, “Getting Started.”](#)

Using Telnet

ExtremeXOS supports the Telnet Protocol based on RFC 854. Telnet allows interactive remote access to a device and is based on a client/server model. ExtremeXOS uses Telnet to connect to other devices from the switch (client) and to allow incoming connections for switch management using the CLI (server).

This section describes the following topics:

- [About the Telnet Client on page 69](#)
- [About the Telnet Server on page 69](#)
- [Connecting to Another Host Using Telnet on page 70](#)
- [Configuring Switch IP Parameters on page 70](#)
- [Configuring Telnet Access to the Switch on page 72](#)
- [Disconnecting a Telnet Session on page 73](#)
- [Access Profile Logging for Telnet on page 74](#)

About the Telnet Client

Before you can start an outgoing Telnet session on the switch, you must set up the IP parameters described in [“Configuring Switch IP Parameters” on page 70](#). Telnet is enabled and uses *VR-Mgmt* by default.

**NOTE**

Maximize the Telnet screen so that automatically updating screens display correctly.

If you use Telnet to establish a connection to the switch, you must specify the IP address or host name of the device that you want to connect to. Check the user manual supplied with the Telnet facility if you are unsure of how to do this.

After the connection is established, you see the switch prompt and you can log in.

The same is true if you use the switch to connect to another host. From the CLI, you must specify the IP address or host name of the device that you want to connect to. If the host is accessible and you are allowed access, you may log in.

For more information about using the Telnet client on the switch, see [“Connecting to Another Host Using Telnet” on page 70](#).

About the Telnet Server

Any workstation with a Telnet facility should be able to communicate with the switch over a TCP/IP network using VT100 terminal emulation.

Up to eight active Telnet sessions can access the switch concurrently. If you enable the idle timer using the `enable idletimeout` command, the Telnet connection times out after 20 minutes of inactivity by default. If a connection to a Telnet session is lost inadvertently, the switch terminates the session within two hours.

The switch accepts IPv6 connections.

For information about the Telnet server on the switch, see the following sections:

- [Configuring Telnet Access to the Switch on page 72](#)
- [Disconnecting a Telnet Session on page 73](#)

Connecting to Another Host Using Telnet

You can Telnet from the current CLI session to another host using the following command:

```
telnet {vr <vr_name>} [<host_name> | <remote_ip>] [<port>]
```



NOTE

User-created VRs are supported only on the platforms listed for this feature in [Appendix A, “Feature License Requirements.”](#)

If the TCP port number is not specified, the Telnet session defaults to port 23. If the virtual router name is not specified, the Telnet session defaults to *VR-Mgmt*. Only VT100 emulation is supported.

You can use Telnet to access either the primary or the backup MSM/MM regardless of which console port you are connected to. For more information see [Chapter 1, “Getting Started.”](#)

Configuring Switch IP Parameters

To manage the switch by way of a Telnet connection or by using an SNMP Network Manager, you must first configure the switch IP parameters.

Using a BOOTP or DHCP Server

If you are using IP and you have a Bootstrap Protocol (BOOTP) server set up correctly on your network, you must provide the following information to the BOOTP server:

- Switch Media Access Control (MAC) address, found on the rear label of the switch
- IP address
- Subnet address mask (optional)

The switch contains a BOOTP and Dynamic Host Configuration Protocol (DHCP) client, so if you have a BOOTP or DHCP server in your IP network, you can have it assign IP addresses to the switch. This is more likely to be desirable on the switch's VLAN *mgmt* than it is on any other VLANs.

You can enable the BOOTP or DHCP client per VLAN by using the following commands:

```
enable bootp vlan [<vlan> | all]
enable dhcp vlan [<vlan_name> | all]
```

You can disable the BOOTP or DHCP client per VLAN by using the following commands:

```
disable bootp vlan [<vlan> | all]
disable dhcp vlan [<vlan_name> | all]
```

To view the current state of the BOOTP or DHCP client, use the following command:

```
show dhcp-client state
```



NOTE

The ExtremeXOS DHCP client will discard the DHCP OFFER if the lease time is less than or equal to 2 seconds.

The switch does not retain IP addresses assigned by BOOTP or DHCP through a power cycle, even if the configuration has been saved. To retain the IP address through a power cycle, you must configure the IP address of the VLAN using the CLI or Telnet.

If you need the switch's MAC address to configure your BOOTP or DHCP server, you can find it on the rear label of the switch. Note that all VLANs configured to use BOOTP or DHCP use the same MAC address to get their IP address, so you cannot configure the BOOTP or DHCP server to assign multiple specific IP addresses to a switch depending solely on the MAC address.

Manually Configuring the IP Settings

If you are using IP without a BOOTP server, you must enter the IP parameters for the switch in order for the SNMP Network Manager or Telnet software to communicate with the device. To assign IP parameters to the switch, you must perform the following tasks:

- Log in to the switch with administrator privileges using the console interface.
- Assign an IP address and subnet mask to a VLAN.

The switch comes configured with a default VLAN named *default*. To use Telnet or an SNMP Network Manager, you must have at least one VLAN on the switch, and that VLAN must be assigned an IP address and subnet mask. IP addresses are always assigned to each VLAN. The switch can be assigned multiple IP addresses (one for each VLAN).



NOTE

For information on creating and configuring VLANs, see [Chapter 12, "VLANs."](#)

To manually configure the IP settings:

- 1 Connect a terminal or workstation running terminal emulation software to the console port, as detailed in ["Using the Console Interface" on page 66](#).
- 2 At your terminal, press [Return] one or more times until you see the login prompt.
- 3 At the login prompt, enter your user name and password. The user name is not case-sensitive. The password is case-sensitive. Ensure that you have entered a user name and password with administrator privileges.

- If you are logging in for the first time, use the default user name *admin* to log in with administrator privileges. For example:

```
login: admin
```

Administrator capabilities enable you to access all switch functions. The default user names have no passwords assigned.

- If you have been assigned a user name and password with administrator privileges, enter them at the login prompt.
- 4 At the password prompt, enter the password and press [Return].

When you have successfully logged in to the switch, the command line prompt displays the name of the switch.

- 5 Assign an IP address and subnetwork mask for the default VLAN by using the following command:

```
configure {vlan} <vlan_name> ipaddress [<ipaddress> {<ipNetmask>} | ipv6-link-
local | {eui64} <ipv6_address_mask>]
```

For example:

```
configure vlan default ipaddress 123.45.67.8 255.255.255.0
```

The changes take effect immediately.



NOTE

As a general rule, when configuring any IP addresses for the switch, you can express a subnet mask by using dotted decimal notation or by using classless inter domain routing notation (CIDR). CIDR uses a forward slash plus the number of bits in the subnet mask. Using CIDR notation, the command identical to the previous example is: `configure vlan default ipaddress 123.45.67.8/24`

- 6 Configure the default route for the switch using the following command:

```
configure iproute add default <gateway> {<metric>} {multicast | multicast-only |
unicast | unicast-only} {vr <vrname>}
```

For example:

```
configure iproute add default 123.45.67.1
```

- 7 Save your configuration changes so that they will be in effect after the next switch reboot.

- If you want to save your changes to the currently booted configuration, use the following command:

```
save
```

- ExtremeXOS allows you to select or create a configuration file name of your choice to save the configuration to. If you want to save your changes to an existing or new configuration file, use the following command:

```
save configuration {primary | secondary | <existing-config> | <new-config>}
```

- 8 When you are finished using the facility, log out of the switch by typing:

```
logout or quit
```

Configuring Telnet Access to the Switch

By default, Telnet services are enabled on the switch and all virtual routers listen for incoming Telnet requests. The switch accepts IPv6 connections.



NOTE

User-created VRs are supported only on the platforms listed for this feature in [Appendix A, "Feature License Requirements."](#)

The safe defaults mode runs an interactive script that allows you to enable or disable SNMP, Telnet, and switch ports. When you set up your switch for the first time, you must connect to the console port to access the switch. After logging in to the switch, you enter safe defaults mode. Although SNMP, Telnet, and switch ports are enabled by default, the script prompts you to confirm those settings.

If you choose to keep the default setting for Telnet—the default setting is enabled—the switch returns the following interactive script:

```
Since you have chosen less secure management methods, please remember to increase
the security of your network by taking the following actions:
* change your admin password
* change your SNMP public and private strings
* consider using SNMPv3 to secure network management traffic
```

For more detailed information about safe defaults mode, see [“Safe Defaults Setup Method” on page 51](#).

To configure the virtual router from which you receive a Telnet request, use the following command:

```
configure telnet vr [all | default | <vr_name>]
```

To change the default TCP port number, use the following command:

```
configure telnet port [<portno> | default]
```

The range for the port number is 1 through 65535. The following TCP port numbers are reserved and cannot be used for Telnet connections: 22, 80, and 1023. If you attempt to configure a reserved port, the switch displays an error message.

Viewing Telnet Information

To display the status of Telnet, including the current TCP port, the virtual router used to establish a Telnet session, and whether ACLs are controlling Telnet access, use the following command:

```
show management
```

Disabling and Enabling Telnet

You can choose to disable Telnet by using the following command:

```
disable telnet
```

To re-enable Telnet on the switch, use the following command:

```
enable telnet
```

You must be logged in as an administrator to configure the virtual router(s) used by Telnet and to enable or disable Telnet.

Disconnecting a Telnet Session

A person with an administrator level account can disconnect a Telnet management session. If this happens, the user logged in by way of the Telnet connection is notified that the session has been terminated.

To terminate a Telnet session:

- 1 Log in to the switch with administrator privileges.
- 2 Determine the session number of the session you want to terminate by using the following command:

```
show session {{detail}} {<sessID>} {history}
```

- 3 Terminate the session by using the following command:

```
clear session [history | <sessId> | all]
```

Access Profile Logging for Telnet

By default, Telnet services are enabled on the switch. The access profile logging feature allows you to use an ACL policy file or dynamic ACL rules to control access to Telnet services on the switch. When access profile logging is enabled for Telnet, the switch logs messages and increments counters when packets are denied access to Telnet. No messages are logged for permitted access.

You can manage Telnet access using one (not both) of the following methods:

- Create and apply an ACL policy file
- Define and apply individual ACL rules

One advantage of ACL policy files is that you can copy the file and use it on other switches. One advantage to applying individual ACL rules is that you can enter the rules at the CLI command prompt, which can be easier than opening, editing, and saving a policy file.

The following sections provide additional information on access profile logging for Telnet:

- [ACL Match Conditions and Actions on page 74](#)
- [Limitations on page 75](#)
- [Managing ACL Policies for Telnet on page 75](#)
- [Managing ACL Rules for Telnet on page 75](#)
- [Misconfiguration Error Messages on page 75](#)
- [Sample ACL Policies on page 76](#)

ACL Match Conditions and Actions

Chapter 18, “ACLs,” describes how to create ACL policies and rules using match conditions and actions. Access profile logging supports the following match conditions and actions:

- Match conditions
 - Source-address—IPv4 and IPv6
- Actions
 - Permit
 - Deny

If the ACL is created with more match conditions or actions, only those listed above are used for validating the packets. All other conditions and actions are ignored.

The *source-address* field allows you to identify an IPv4 address, IPv6 address, or subnet mask for which access is either permitted or denied.

Limitations

This feature has the following limitations:

- Either policy files or ACL rules can be associated with Telnet, but not both at the same time.
- Only source-address match is supported.
- Access-lists that are associated with one or more applications cannot be directly deleted. They must be unconfigured from the application first and then deleted from the CLI.
- Default counter support is added only for ACL rules and not for policy files. For policy files you must configure count action.

Managing ACL Policies for Telnet

[Chapter 18, “ACLs,”](#) describes how to create ACL policy files. To configure Telnet to use an ACL policy, use one of the following command:

```
configure telnet access-profile <profile_name>
```

To configure Telnet to remove a previously configured ACL policy, use the following command:

```
configure telnet access-profile none
```



NOTE

Do not also apply the policy to the access list. Applying a policy to both an access profile and an access list is neither necessary nor recommended.

Managing ACL Rules for Telnet

Before you can assign an ACL rule to Telnet, you must create a dynamic ACL rule as described in [Chapter 18, “ACLs.”](#) To add or delete a rule for Telnet access, use the following command:

```
configure telnet access-profile [ <access_profile> | [[add <rule> ] [first | [[before | after] <previous_rule>]]] | delete <rule> | none ]
```

To display the access-list permit and deny statistics for an application, use the following command:

```
show access-list counters process [snmp | telnet | ssh2 | http]
```

Misconfiguration Error Messages

The following messages can appear during configuration of policies or rules for the SNMP service:

- Rule <rule> is already applied
A rule with the same name is already applied to this service.
- Please remove the policy <policy> already configured, and then add rule <rule>
A policy file is already associated with the service. You must remove the policy before you can add a rule.
- Rule <previous_rule> is not already applied
The specified rule has not been applied to the service, so you cannot add a rule in relation to that rule.

- Rule <rule> is not applied

The specified rule has not been applied to the service, so you cannot remove the rule from the service.

- Error: Please remove previously configured rule(s) before configuring policy <policy>

A policy or one or more ACL rules are configured for the service. You must delete the remove the policy or rules from the service before you can add a policy.

Sample ACL Policies

The following are sample policies that you can apply to restrict Telnet access.

In the following example named MyAccessProfile.pol, the switch permits connections from the subnet 10.203.133.0/24 and denies connections from all other addresses:

```
MyAccessProfile.pol
entry AllowTheseSubnets {
    if {
        source-address 10.203.133.0 /24;
    } then {
        permit;
    }
}
```

In the following example named MyAccessProfile.pol, the switch permits connections from the subnets 10.203.133.0/24 or 10.203.135.0/24 and denies connections from all other addresses:

```
MyAccessProfile.pol
entry AllowTheseSubnets {
    if match any {
        source-address 10.203.133.0 /24;
        source-address 10.203.135.0 /24;
    } then {
        permit;
    }
}
```

In the following example named MyAccessProfile_2.pol, the switch does not permit connections from the subnet 10.203.133.0/24 but accepts connections from all other addresses:

```
MyAccessProfile_2.pol
entry dontAllowTheseSubnets {
    if {
        source-address 10.203.133.0 /24;
    } then {
        deny;
    }
}
entry AllowTheRest {
    if {
        ; #none specified
    } then {
        permit;
    }
}
```

In the following example named `MyAccessProfile_2.pol`, the switch does not permit connections from the subnets `10.203.133.0/24` or `10.203.135.0/24` but accepts connections from all other addresses:

```
MyAccessProfile_2.pol
entry dontAllowTheseSubnets {
    if match any {
        source-address 10.203.133.0 /24;
        source-address 10.203.135.0 /24;
    } then {
        deny;
    }
}

entry AllowTheRest {
    if {
        ; #none specified
    } then {
        permit;
    }
}
```

Using Secure Shell 2

The following sections describe this feature:

- [SSH2 Overview on page 77](#)
- [Access Profile Logging for SSH2 on page 78](#)

SSH2 Overview

Secure Shell 2 (SSH2) is a feature of the ExtremeXOS software that allows you to encrypt session data between a network administrator using SSH2 client software and the switch or send encrypted data from the switch to an SSH2 client on a remote system. Configuration, image, public key, and policy files can be transferred to the switch using the Secure Copy Protocol 2 (SCP2) or the Secure File Transfer Protocol (SFTP).

The ExtremeXOS SSH2 switch application works with the following clients: Putty, SSH2 (version 2.x or later) from SSH Communication Security, and OpenSSH (version 2.5 or later). OpenSSH uses the RCP protocol, which has been disabled from the ExtremeXOS software for security reasons. Therefore, OpenSSH SCP does not work with the ExtremeXOS SSH implementation. You can use OpenSSH SFTP instead.

The switch accepts IPv6 connections.

Up to eight active SSH2 sessions can run on the switch concurrently. If you enable the idle timer using the `enable idletimeout` command, the SSH2 connection times out after 20 minutes of inactivity by default. If you disable the idle timer using the `disable idletimeout` command, the SSH2 connection times out after 61 minutes of inactivity. If a connection to an SSH2 session is lost inadvertently, the switch terminates the session within 61 minutes.

For detailed information about SSH2, see [Chapter 23, “Security.”](#)

Access Profile Logging for SSH2

The access profile logging feature allows you to use an ACL policy file or dynamic ACL rules to control access to SSH2 services on the switch. When access profile logging is enabled for SSH2, the switch logs messages and increments counters when packets are denied access to SSH2. No messages are logged for permitted access.

You can manage SSH2 access using one (not both) of the following methods:

- Create and apply an ACL policy file
- Define and apply individual ACL rules

One advantage of ACL policy files is that you can copy the file and use it on other switches. One advantage to applying individual ACL rules is that you can enter the rules at the CLI command prompt, which can be easier than opening, editing, and saving a policy file.

The following sections provide additional information on access profile logging for SSH2:

- [ACL Match Conditions and Actions on page 78](#)
- [Limitations on page 78](#)
- [Managing ACL Policies for SSH2 on page 79](#)
- [Managing ACL Rules for SSH2 on page 79](#)
- [Misconfiguration Error Messages on page 79](#)

ACL Match Conditions and Actions

Chapter 18, “ACLs,” describes how to create ACL policies and rules using match conditions and actions. Access profile logging supports the following match conditions and actions:

- Match conditions
 - Source-address—IPv4 and IPv6
- Actions
 - Permit
 - Deny

If the ACL is created with more match conditions or actions, only those listed above are used for validating the packets. All other conditions and actions are ignored.

The *source-address* field allows you to identify an IPv4 address, IPv6 address, or subnet mask for which access is either permitted or denied.

Limitations

This feature has the following limitations:

- Either policy files or ACLs can be associated with SSH2, but not both at the same time.
- Only source-address match is supported.
- Access-lists that are associated with one or more applications cannot be directly deleted. They must be unconfigured from the application first and then deleted from the CLI.
- Default counter support is added only for ACL rules and not for policy files. For policy files you must configure count action.

Managing ACL Policies for SSH2

Chapter 18, “ACLs,” describes how to create ACL policy files. To configure SSH2 to use an ACL policy, use one of the following command:

```
configure ssh2 access-profile <profile_name>
```

To configure SSH2 to remove a previously configured ACL policy, use the following command:

```
configure ssh2 access-profile none
```

Managing ACL Rules for SSH2

Before you can assign an ACL rule to SSH2, you must create a dynamic ACL rule as described in Chapter 18, “ACLs.” To add or delete a rule for SSH2 access, use the following command:

```
configure ssh2 access-profile [ <access_profile> | [[add <rule> ] [first | [[before | after] <previous_rule>]]] | delete <rule> | none ]
```

To display the access-list permit and deny statistics for an application, use the following command:

```
show access-list counters process [snmp | telnet | ssh2 | http]
```

Misconfiguration Error Messages

The following messages can appear during configuration of policies or rules for the SSH2 service:

- Rule <rule> is already applied
A rule with the same name is already applied to this service.
- Please remove the policy <policy> already configured, and then add rule <rule>
A policy file is already associated with the service. You must remove the policy before you can add a rule.
- Rule <previous_rule> is not already applied
The specified rule has not been applied to the service, so you cannot add a rule in relation to that rule.
- Rule <rule> is not applied
The specified rule has not been applied to the service, so you cannot remove the rule from the service.
- Error: Please remove previously configured rule(s) before configuring policy <policy>
A policy or one or more ACL rules are configured for the service. You must delete the remove the policy or rules from the service before you can add a policy.

Using the Trivial File Transfer Protocol

ExtremeXOS supports the Trivial File Transfer Protocol (TFTP) based on RFC 1350. TFTP is a method used to transfer files from one network device to another. The ExtremeXOS TFTP client is a command line application used to contact an external TFTP server on the network. For example, ExtremeXOS uses TFTP to download software image files, switch configuration files, and ACLs from a server on the network to the switch.

Up to eight active TFTP sessions can run on the switch concurrently.

Extreme Networks recommends using a TFTP server that supports blocksize negotiation (as described in RFC 2348, *TFTP Blocksize Option*), to enable faster file downloads and larger file downloads.

For additional information about TFTP, see the following chapters:

- For information about downloading software image files, BootROM files, and switch configurations, see [Appendix B, “Software Upgrade and Boot Options.”](#)
- For information about downloading ACL (and other) policy files, see [Chapter 17, “Policy Manager.”](#)
- For information about using TFTP to transfer files to and from the switch, see [Chapter 3, “Managing the ExtremeXOS Software.”](#)
- For information about configuring core dump files and transferring the core dump files stored on your switch, see [Appendix D, “Troubleshooting.”](#)

Connecting to Another Host Using TFTP

You can TFTP from the current CLI session to another host to transfer files using the following command:

```
tftp [<host-name> | <ip-address>] {-v <vr_name>} [-g | -p] [{"-l [internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local-file>} {-r <remote-file>} | {"-r <remote-file>} {"-l [internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local-file>}]}]
```



NOTE

User-created VRs are supported only on the platforms listed for this feature in [Appendix A, “Feature License Requirements.”](#)

The TFTP session defaults to port 69. If you do not specify a virtual router, *VR-Mgmt* is used.

For example, to connect to a remote TFTP server with an IP address of 10.123.45.67 and “get” or retrieve an ExtremeXOS configuration file named XOS1.cfg from that host, use the following command:

```
tftp 10.123.45.67 -g -r XOS1.cfg
```

When you “get” the file via TFTP, the switch saves the file to the primary MSM/MM. If the switch detects a backup MSM/MM in the running state, the file is replicated to the backup MSM/MM.

To view the files you retrieved, enter the `ls` command at the command prompt.

In addition to the `tftp` command, the following two commands are available for transferring files to and from the switch:

- `tftp get [<host-name> | <ip-address>] {-vr <vr_name>} [{"[internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local_file>} {<remote_file>} | {"<remote_file>} [{"internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local_file>}]}] {force-overwrite}`



NOTE

User-created VRs are supported only on the platforms listed for this feature in [Appendix A, “Feature License Requirements.”](#)

By default, if you transfer a file with a name that already exists on the system, the switch prompts you to overwrite the existing file. For more information, see the `tftp get` command in the ExtremeXOS Command Reference Guide.

- `tftp put [<host-name> | <ip-address>] {-vr <vr_name>} [[[internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local_file>] {<remote_file>} | {<remote_file>} [[internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local_file>]]]`



NOTE

User-created VRs are supported only on the platforms listed for this feature in [Appendix A, “Feature License Requirements.”](#)

Understanding System Redundancy—Modular Switches and SummitStack Only

If you install two MSMs/MM or nodes in the chassis, or if you configure two master-capable nodes in a SummitStack, one assumes the role of primary (also called "master") and the other assumes the role of backup. The primary MSM/MM or node provides all of the switch management functions including bringing up and programming the I/O modules, running the bridging and routing protocols, and configuring the switch. The primary MSM/MM or node also synchronizes the backup MSM/MM or node in case it needs to take over the management functions if the primary MSM/MM or node fails.

For SummitStack, a node can be a redundant primary node if it has been configured to be master-capable. To configure master capability on one or all nodes in a SummitStack, use one of the following commands:

- `configure stacking [node-address <node-address> | slot <slot-number>] alternate-ip-address [<ipaddress> <netmask> | <ipNetmask>] <gateway>`
- `configure stacking redundancy [none | minimal | maximal]`

This section describes the following topics:

- [Node Election on page 81](#)
- [Replicating Data Between Nodes on page 83](#)
- [Viewing Node Status on page 85](#)

Node Election

Node election is based on leader election between the MSMs/MMs installed in the chassis, or master-capable nodes present in a SummitStack. By default, the MSM/MM installed in slot A or the SummitStack node in slot 1 has primary status. Each node uses *health* information about itself together with a user configured priority value to compute its node role election priority. Nodes exchange their node role election priorities. During the node election process, the node with the highest node role election priority becomes the master or primary node, and the node with the second highest node role election priority becomes the backup node. All other nodes (if any) remain in STANDBY state.

The primary node runs the switch management functions, and the backup node is fully prepared to become the primary node if the primary fails. In SummitStack, nodes that remain in STANDBY state (called *Standby nodes*) program their port hardware based on instructions received from the primary.

Standby nodes configured to be master-capable elect a new backup node from among themselves after a failover has occurred.

Determining the Primary Node

The following parameters determine the primary node:

- Node state—The node state must be STANDBY to participate in leader election and be selected as primary. If the node is in the INIT, DOWN, or FAIL states, it cannot participate in leader election. For more information about the node states, see [“Viewing Node Status” on page 85](#).
- Configuration priority—This is a user assigned priority. The configured priority is compared only after the node meets the minimum thresholds in each category for it to be healthy. Required processes and devices must not fail.
- Software health—This represents the percent of processes available.
- Health of secondary hardware components—This represents the health of the switch components, such as power supplies, fans, and so forth.
- Slot ID—The MSM/MM slot where the node is installed (MSM-A or MSM-B), or the slot number configured on a stack node.

Configuring the Node Priority on a Modular Switch

To configure the priority of an MSM/MM node, use the following command:

```
configure node slot <slot_id> priority <node_pri>
```

If you do not configure any priorities, MSM-A has a higher priority than MSM-B. For the `slot_id` parameter, enter A for the MSM/MM installed in slot A or B for the MSM/MM installed in slot B. By default, the priority is 0 and the node priority range is 1 through 100. The higher the value, the higher the priority.

Configuring the Node Priority on a SummitStack

To configure the priority of a node in a SummitStack, use the following command:

```
configure stacking {node-address <node-address> | slot <slot-number>} priority [<node-pri> | automatic]
```

If you do not configure any priorities, slot 1 has the highest priority, slot 2 the second highest priority, and so forth in order of increasing slot number. Enter a number from 1 through 8 for the `slot-number`. You may also use the factory assigned MAC address as the `node-address` value. By default the priority is "automatic" and the `node-pri` value is any number between 1 and 100. The higher the value, the higher the priority.

Relinquishing Primary Status

Before relinquishing primary status and initiating failover, review the section [“Synchronizing Nodes—Modular Switches and SummitStack Only” on page 1500](#) to confirm that your platform and both installed MSMs/MMs or master-capable nodes are running software that supports the `synchronize` command.

You can cause the primary to failover to the backup, thereby relinquishing its primary status. To cause the failover:

- 1 Use the `show switch {detail}` command on the primary or the backup node to confirm that the nodes are synchronized and have identical software and switch configurations before failover. The output displays the status of the nodes, with the primary node showing `MASTER` and the backup node showing `BACKUP (InSync)`.

A node may not be synchronized because checkpointing did not occur, incompatible software is running on the primary and backup, or the backup is down.

- If the nodes are not synchronized and both nodes are running a version of ExtremeXOS that supports synchronization, proceed to step 2.
 - If the nodes are synchronized, proceed to step 3.
- 2 If the nodes are not synchronized because of incompatible software, use the `synchronize` command to ensure that the backup has the same software in flash as the primary.

The `synchronize` command:

- Reboots the backup node to prepare it for synchronizing with the primary node
- Copies both the primary and secondary software images
- Copies both the primary and secondary configurations
- Reboots the backup node after replication is complete

After you confirm the nodes are synchronized, proceed to step 3.

- 3 If the nodes are synchronized, use the `run failover {force}` command to initiate failover from the primary node to the backup node. The backup node then becomes the primary node and the original primary node reboots.

Replicating Data Between Nodes

ExtremeXOS replicates configuration and run-time information between the primary node and the backup node so that the system can recover if the primary fails. This method of replicating data is known as checkpointing. Checkpointing is the process of automatically copying the active state from the primary to the backup, which allows for state recovery if the primary fails.

Replicating data consists of the following three steps:

- 1 Configuration synchronization—Relays current and saved configuration information from the primary to the backup
- 2 Bulk checkpoint—Ensures that each individual application running on the system is synchronized with the backup
- 3 Dynamic checkpoint—Checkpoint any new state changes from the primary to the backup

To monitor the checkpointing status, use the `show checkpoint-data {<process>}` command.

Data is not replicated from the primary to the standby nodes.

Relaying Configuration Information

To facilitate a failover from the primary node to the backup node, the primary transfers its active configuration to the backup. Relaying configuration information is the first level of checkpointing. During the initial switch boot-up, the primary's configuration takes effect. During the initialization of a node, its configuration is read from the local flash. After the primary and backup nodes have been elected, the primary transfers its current active configuration to the backup. After the primary and

backup nodes are synchronized, any configuration change you make to the primary is relayed to the backup and incorporated into the backup's configuration copy.

**NOTE**

To ensure that all of the configuration commands in the backup's flash are updated, issue the `save` command after you make any changes. On a SummitStack, the `save configuration` command will normally save the primary node's configuration file to all active nodes in the SummitStack.

If a failover occurs, the backup node continues to use the primary's active configuration. If the backup determines that it does not have the primary's active configuration because a run-time synchronization did not happen, the switch or SummitStack reboots. Because the backup always uses the primary's active configuration, the active configuration remains in effect regardless of the number of failovers.

**NOTE**

If you issue the `reboot` command before you save your configuration changes, the switch prompts you to save your changes. To keep your configuration changes, save them before you reboot the switch.

Bulk Checkpointing

Bulk checkpointing causes the primary and backup run-time states to be synchronized. Since ExtremeXOS runs a series of applications, an application starts checkpointing only after all of the applications it depends on have transferred their run-time states to the backup MSM/MM node.

After one application completes bulk checkpointing, the next application proceeds with its bulk checkpointing.

To monitor the checkpointing status, use the `show checkpoint-data {<process>}` command.

To see if bulk checkpointing is complete, that is, to see if the backup node is fully synchronized (*In Sync*) with the primary node, use the `show switch {detail}` command.

If a failover occurs before bulk checkpointing is complete, the switch or SummitStack reboots. However, once bulk checkpointing is complete, failover is possible without a switch or SummitStack reboot.

Dynamic Checkpointing

After an application transfers its saved state to the backup node, dynamic checkpointing requires that any new configuration information or state changes that occur on the primary be immediately relayed to the backup. This ensures that the backup has the most up-to-date and accurate information.

Viewing Checkpoint Statistics

To view and check the status of one or more processes being copied from the primary to the backup node, use the following command:

```
show checkpoint-data {<process>}
```

This command is also helpful in debugging synchronization problems that occur at run time.

This command displays, in percentages, the amount of copying completed by each process and the traffic statistics between the process on both the primary and the backup nodes.

Viewing Node Status

ExtremeXOS allows you to view node statistical information. Each node in a modular switch, or stackable switch in a SummitStack installed in your system is self-sufficient and runs the ExtremeXOS management applications. By reviewing this output, you can see the general health of the system along with other node parameters.

To view node status, use the following command:

```
show node {detail}
```

In a SummitStack, the "show stacking" command will show the node roles of active nodes.

Table 13 lists the node status collected by the switch.

Table 13: Node States

Node State	Description
BACKUP	In the backup state, this node becomes the primary node if the primary fails or enters the DOWN state. The backup node also receives the checkpoint state data from the primary.
DOWN	In the down state, the node is not available to participate in leader election. The node enters this state during any user action, other than a failure, that makes the node unavailable for management. Examples of user actions are: <ul style="list-style-type: none"> • Upgrading the software • Rebooting the system using the <code>reboot</code> command • Initiating an MSM/MM failover using the <code>run failover</code> command • Synchronizing the MSM/MM software and configuration in non-volatile storage using the <code>synchronize</code> command
FAIL	In the fail state, the node has failed and needs to be restarted or repaired. The node reaches this state if the system has a hardware or software failure.
INIT	In the initial state, the node is being initialized. A node stays in this state when it is coming up and remains in this state until it has been fully initialized. Being fully initialized means that all of the hardware has been initialized correctly and there are no diagnostic faults.
MASTER	In the primary (master) state, the node is responsible for all switch management functions.
STANDBY	In the standby state, leader election occurs—the primary and backup nodes are elected. The priority of the node is only significant in the standby state. In SummitStack, there can be more than two master-capable nodes. All such nodes that do not get elected either Master or Backup remain in Standby state.

Understanding Hitless Failover Support—Modular Switches and SummitStack Only

The term *hitless failover* has slightly different meanings on a modular chassis and a SummitStack. On a modular chassis, MSMs/MMs do not directly control customer ports; such ports are directly controlled by separate processors. However, a SummitStack node has customer ports that are under the control of its single central processor. When a modular chassis MSM/MM failover occurs, all of the ports in the chassis are under the control of separate processors which can communicate with the backup MSM/

MM, so all ports continue to function. In a SummitStack, failure of the primary node results in all ports that require that node's processor for normal operation going down. The remaining SummitStack nodes' ports continue to function normally. Aside from this difference, hitless failover is the same on modular chassis and SummitStack.

**NOTE**

BlackDiamond 8500 modules and BlackDiamond 12802 switches do not support hitless failover.

As described in the section, “[Understanding System Redundancy—Modular Switches and SummitStack Only](#)” on page 81, if you install two MSMs/MMs (nodes) in a chassis or if you configure at least two master-capable nodes in a SummitStack, one assumes the role of primary and the other assumes the role of backup. The primary node provides all of the switch management functions including bringing up and programming the I/O modules or other (Standby) nodes in the SummitStack, running the bridging and routing protocols, and configuring the switch. The primary node also synchronizes the backup node in case it needs to take over the management functions if the primary node fails.

The configuration is one of the most important pieces of information checkpointed to the backup node. Each component of the system needs to checkpoint whatever runtime data is necessary to allow the backup node to take over as the primary node if a failover occurs, including the protocols and the hardware dependent layers. For more information about checkpointing data and relaying configuration information, see “[Replicating Data Between Nodes](#)” on page 83.

Not all protocols support hitless failover; see [Table 14](#) for a detailed list of protocols and their support. Layer 3 forwarding tables are maintained for pre-existing flows, but subsequent behavior depends on the routing protocols used. Static Layer 3 configurations and routes are hitless. You must configure OSPF graceful restart for OSPF routes to be maintained, and you must configure BGP graceful restart for BGP routes to be maintained. For more information about OSPF, see [Chapter 35, “OSPF Commands,”](#) and for more information about BGP, see [Chapter 38, “BGP.”](#) For routing protocols that do not support hitless failover, the new primary node removes and re-adds the routes.

Protocol Support for Hitless Failover

[Table 14](#) summarizes the protocol support for hitless failover. Unless otherwise noted, the behavior is the same for all modular switches.

If a protocol indicates support for hitless failover, additional information is also available in that particular chapter. For example, for information about network login support of hitless failover, see [Chapter 21, “Network Login.”](#)

Table 14: Protocol Support for Hitless Failover

Protocol	Behavior	Hitless
Bootstrap Protocol Relay	All bootprelay statistics (including option 82 statistics) are available on the backup node also	Yes
Border Gateway Protocol (BGP)	<p>If you configure BGP graceful restart, by default the route manager does not delete BGP routes until 120 seconds after failover occurs. There is no traffic interruption. However, after BGP comes up after restart, BGP re-establishes sessions with its neighbors and relearns routes from all of them. This causes an increase in control traffic onto the network.</p> <p>If you do not configure graceful restart, the route manager deletes all BGP routes 1 second after the failover occurs, which results in a traffic interruption in addition to the increased control traffic.</p>	Yes
Connectivity Fault Management (IEEE 802.1ag)	<p>An ExtremeXOS process running on the active MSM/MM should continuously send the MEP state changes to the backup. Replicating the protocol packets from an active MSM/MM to a backup may be a huge overhead if CCMs are to be initiated/received in the CPU and if the CCM interval is in the order of milliseconds.</p> <p>RMEP timeout does not occur on a remote node during the hitless failover.</p> <p>RMEP expiry time on the new master node in case of double failures, when the RMEP expiry timer is already in progress, is as follows: $RMEP \text{ Expiry Time} = \text{elapsed expiry time on the master node} + 3.5 * \text{ccmIntervaltime} + \text{MSM convergence time}.$</p>	Yes
Dynamic Host Configuration Protocol client	The IP addresses learned on all DHCP enabled VLANs are retained on the backup node after failover.	Yes
Dynamic Host Configuration Protocol server	A DHCP server continues to maintain the IP addresses assigned to various clients and the lease times even after failover. When a failover happens, all the clients work as earlier.	Yes
Ethernet Automatic Protection Switching (EAPS)	<p>The primary node replicates all EAPS BPDUs to the backup, which allows the backup to be aware of the state of the EAPS domain. Since both primary and backup nodes receive EAPS BPDUs, each node maintains equivalent EAPS states.</p> <p>By knowing the state of the EAPS domain, the EAPS process running on the backup node can quickly recover after a primary node failover. Although both primary and backup nodes receive EAPS BPDUs, only the primary transmits EAPS BPDUs to neighboring switches and actively participates in EAPS.</p>	Yes
Extreme Discovery Protocol (EDP)	EDP does not checkpoint protocol data units (PDUs) or states, so the backup node does not have the neighbor's information. If the backup node becomes the primary node, and starts receiving PDUs, the new primary learns about its neighbors.	No
Extreme Loop Recovery Protocol (ELRP)	<p>If you use ELRP as a standalone tool, hitless failover support is not needed since the you initiate the loop detection.</p> <p>If you use ELRP in conjunction with ESRP, ELRP does not interfere with the hitless failover support provided by ESRP.</p> <p>Although there is no hitless failover support in ELRP itself, ELRP does not affect the network behavior if a failover occurs.</p>	No

Table 14: Protocol Support for Hitless Failover (Continued)

Protocol	Behavior	Hitless
Extreme Standby Router Protocol (ESRP)	<p>If failover occurs on the ESRP MASTER switch, it sends a hello packet with the HOLD bit set. On receiving this packet, the ESRP SLAVE switch freezes all further state transitions. The MASTER switch keeps sending hellos with the HOLD bit set on every hello interval. When the MASTER is done with its failover, it sends another hello with the HOLD bit reset. The SLAVE switch resumes normal processing. (If no packet is received with the HOLD bit reset, the SLAVE timeouts after a certain time interval and resumes normal processing.)</p> <p>Failover on the ESRP SLAVE switch is of no importance because it is the SLAVE switch.</p>	Yes
Intermediate System-Intermediate System (IS-IS)	<p>If you configure IS-IS graceful restart, there is no traffic interruption. However, after IS-IS comes up after restart, IS-IS re-establishes sessions with its neighbors and relearns Link State Packets (LSPs) from all of the neighbors. This causes an increase in network control traffic.</p> <p>If you do not configure graceful restart, the route manager deletes all IS-IS routes 1 second after the failover occurs, which results in a traffic interruption and increased control traffic. IS-IS for IPv6 does not support hitless restart.</p>	IS-IS (IPv4) Yes IS-IS (IPv6) No
Link Aggregation Control Protocol (LACP)	If the backup node becomes the primary node, there is no traffic disruption.	Yes
Link Layer Discovery Protocol (LLDP)	Since LLDP is more of a tool than a protocol, there is no hitless failover support. LLDP is similar to EDP, but there is also a MIB interface to query the information learned. After a failover, it takes 30 seconds or greater before the MIB database is fully populated again.	No
Multicast Source Discovery Protocol (MSDP)	If the active MSM/MM fails, the MSDP process loses all state information and the standby MSM/MM becomes active. However, the failover from the active MSM/MM to the standby MSM/MM causes MSDP to lose all state information and dynamic data, so it is not a hitless failover.	No
Multi-switch Link Aggregation Group (MLAG)	<p>All MLAG user configuration is executed on both Master and Backup nodes. Both nodes open listening health-check and checkpoint listening sockets on the respective well-known ports. All FDB entries and IPMC group/cache information that were received through ISC checkpointing is synchronized to the backup node.</p> <p>After failover, the TCP session, which is handled by the failed master, tears down and there is a new session with the MLAG peer switch. After the failover, the FDB & McMgr processes trigger bulk checkpointing of all its entries to the MLAG peer upon receiving ISC up notification.</p>	Yes
Network Login	<p>802.1x Authentication</p> <p>Authenticated clients continue to remain authenticated after failover. However, 1 second after failover, all authenticated clients are forced to re-authenticate themselves.</p> <p>Information about unauthenticated clients is not checkpointed so any such clients that were in the process of being authenticated at the instant of failover must go through the authentication process again from the beginning after failover.</p>	Yes

Table 14: Protocol Support for Hitless Failover (Continued)

Protocol	Behavior	Hitless
Network Login Continued	<p>MAC-Based Authentication</p> <p>Authenticated clients continue to remain authenticated after failover so the failover is transparent to them. Information about unauthenticated clients is not checkpointed so any such clients that were in the process of being authenticated at the instant of failover must go through the authentication process again from the beginning after failover.</p> <p>In the case of MAC-Based authentication, the authentication process is very short with only a single packet being sent to the switch so it is expected to be transparent to the client stations.</p>	Yes
Network Login Continued	<p>Web-Based Authentication</p> <p>Web-based Netlogin users continue to be authenticated after a failover.</p>	Yes
Open Shortest Path First (OSPF)	<p>If you configure OSPF graceful restart, there is no traffic interruption. However, after OSPF comes up after restart, OSPF re-establishes sessions with its neighbors and relearns Link State Advertisements (LSAs) from all of the neighbors. This causes an increase in control traffic onto the network.</p> <p>If you do not configure graceful restart, the route manager deletes all OSPF routes 1 second after the failover occurs, which results in a traffic interruption in addition to the increased control traffic.</p>	Yes
Open Shortest Path First v3 (OSPFv3)	<p>OSPFv3 does not support graceful restart, so the route manager deletes all OSPFv3 routes 1 second after the failover occurs. This results in a traffic interruption.</p> <p>After OSPFv3 comes up on the new primary node, it relearns the routes from its neighbors. This causes an increase in control traffic onto the network.</p>	No
Power over Ethernet (PoE)	<p>The PoE configuration is checkpointed to the backup node. This ensures that if the backup takes over, all ports currently powered stay powered after the failover and the configured power policies are still in place.</p> <p>This behavior is applicable only on the BlackDiamond 8800 series switches and SummitStack.</p>	Yes
Protocol Independent Multicast (PIM)	<p>After a failover, all hardware and software caches are cleared and learning from the hardware is restarted. This causes a traffic interruption since it is the same as if the switch rebooted for all Layer 3 multicast traffic.</p>	No
Routing Information Protocol (RIP)	<p>RIP does not support graceful restart, so the route manager deletes all RIP routes 1 second after the failover occurs. This results in a traffic interruption as well as an increase in control traffic as RIP re-establishes its database.</p>	No
Routing Information Protocol next generation (RIPng)	<p>RIPng does not support graceful restart, so the route manager deletes all RIPng routes 1 second after the failover occurs. This results in a traffic interruption.</p> <p>After RIPng comes up on the new primary node, it relearns the routes from its neighbors. This causes an increase in control traffic onto the network.</p>	No
Simple Network Time Protocol Client	<p>SNTP client will keep the backup node updated about the last server from which a valid update was received, the time at which the last update was received, whether the SNTP time is currently good or not and all other statistics.</p>	Yes

Table 14: Protocol Support for Hitless Failover (Continued)

Protocol	Behavior	Hitless
Spanning Tree Protocol (STP)	STP supports hitless failover including catastrophic failure of the primary node without interruption. There should be no discernible network event external to the switch. The protocol runs in lock step on both master and backup nodes and the backup node is a hot spare that can take over at any time with no impact on the network.	Yes
Virtual Router Redundancy Protocol (VRRP)	VRRP supports hitless failover. The primary node replicates VRRP PDUs to the backup, which allows the primary and backup nodes to run VRRP in parallel. Although both nodes receive VRRP PDUs, only the primary transmits VRRP PDUs to neighboring switches and participates in VRRP.	Yes

Platform Support for Hitless Failover

Table 15 lists when each platform and management module began supporting hitless failover for a specific protocol. If you are running an earlier version of ExtremeXOS than that listed in the ExtremeXOS version column, the switch does not support hitless failover for that protocol.

Hitless failover requires a switch with two MSMs/MMs installed.

Remember, as described in Table 14, not all protocols support hitless failover.

Table 15: Platform Support for Hitless Failover

Platform	Management Module	Protocol	ExtremeXOS Version
BlackDiamond 8800 series switches	MSM-48c	BGP graceful restart	12.1
		EAPS	12.1
		ESRP	12.1
		LACP	12.1
		MLAG	12.5
		Network login	12.1
		OSPF graceful restart	12.1
		PoE	12.1
		STP	12.1
		VRRP	12.1
	8900-MSM128	IS-IS graceful restart	12.1
		BGP graceful restart	12.3
		EAPS	12.3
		ESRP	12.3
		LACP	12.3
		MLAG	12.5
		Network login	12.3
		OSPF graceful restart	12.3
		PoE	12.3
		STP	12.3
VRRP	12.3		

Table 15: Platform Support for Hitless Failover (Continued)

Platform	Management Module	Protocol	ExtremeXOS Version
BlackDiamond X8 switch SummitStack	MM Any Summit family switch except the Summit X150, X350, and X440-L2 series. (features available depend on license level)	IS-IS graceful restart	12.3
		All applicable	15.1
		BGP graceful restart	12.0
		EAPS	12.0
		ESRP	12.0
		LACP	12.0
		MLAG	12.5
		Network login	12.0
		OSPF graceful restart	12.0
		STP	12.0
VRRP	12.0		
IS-IS graceful restart	12.1		

Hitless Failover Caveats

This section describes the caveats for hitless failover. Check the latest version of the ExtremeXOS release notes for additional information.

Caveat for BlackDiamond 8800 Series Switches Only

The following summary describes the hitless failover caveat for BlackDiamond 8800 series switches:

- I/O modules not yet in the Operational state are
- ed off and the card state machine is restarted to bring them to the Operational state. This results in a delay in the I/O module becoming Operational.

Caveats for a SummitStack

The following describes the hitless failover caveats for a SummitStack:

- All customer ports and the stacking links connected to the failed primary node will go down. In the recommended stack ring configuration, the stack becomes a daisy chain until the failed node restarts or is replaced.
- A brief traffic interruption (less than 50 milliseconds) can occur when the traffic on the ring is rerouted because the active topology becomes a daisy chain.
- Since the SummitStack can contain more than two master-capable nodes, it is possible to immediately elect a new backup node. If a new backup node is elected, when the original primary node restarts, it will become a standby node.
- To simulate the behavior of a chassis, a MAC address of one of the nodes is designated as the seed to form a *stack MAC address*. When a failover occurs, the SummitStack continues to be identified with this address.

- During an OSPF graceful restart, the SummitStack successfully restores the original link state database only if the OSPF network remains stable during the restart period. If the failed primary node provided interfaces to OSPF networks, the link state database restoration is prematurely terminated, and reconvergence occurs in the OSPF network due to the failover. See [Chapter 35, “OSPF,”](#) for a description of OSPF and the graceful restart function.
- During a BGP graceful restart, the SummitStack successfully restores the BGP routing table only if the BGP network remains stable during the restart period. If a *receiving speaker* detected the need for a routing change due to the failure of links on the failed primary node, it deletes any previous updates it received from the restarting speaker (the SummitStack) before the restart occurred. Consequently, reconvergence occurs in the BGP network due to the failover. See [Chapter 38, “BGP,”](#) for a description of BGP and its graceful restart function.

Understanding Power Supply Management

This section describes how ExtremeXOS manages power consumption on the switch:

- [Using Power Supplies—Modular Switches Only on page 92](#)
- [Using Power Supplies—Summit Family Switches Only on page 97](#)
- [Using Power Supplies - SummitStack Only on page 97](#)
- [Displaying Power Supply Information on page 97](#)
- [Power Visualization on page 96](#)

Using Power Supplies—Modular Switches Only

ExtremeXOS monitors and manages power consumption on the switch by periodically checking the power supply units (PSUs) and testing them for failures. To determine the health of the PSU, ExtremeXOS checks the voltage, current, and temperature of the PSU.

The power management capability of ExtremeXOS:

- Protects the system from overload conditions
- Monitors all installed PSUs, even installed PSUs that are disabled
- Enables and disables PSUs as required
- Powers up or down I/O and/or Fabric modules based on available power and required power resources
- Logs power resource changes, including power budget, total available power, redundancy, and so on
- Detects and isolates faulty PSUs

The switch includes two power supply controllers that collect data from the installed PSUs and report the results to the MSM/MM modules. When you first power on the switch, the power supply controllers enable a PSU. As part of the power management function, the power controller disables the PSU if an unsafe condition arises. For more information about the power supply controller, refer to the hardware documentation which is listed in the Preface.

If you have a BlackDiamond 8000 series Power over Ethernet (PoE) I/O module installed in a BlackDiamond 8800 series switch, there are specific power budget requirements and configurations associated with PoE that are not described in this section. For more detailed information about PoE, see [Chapter 10, “PoE.”](#)

ExtremeXOS includes support for the 600/900 W AC PSU for the BlackDiamond 8806 switch. You can mix existing 700/1200 W AC PSUs and 600/900 W AC PSUs in the same chassis; however, you must be running ExtremeXOS 11.6 or later to support the 600/900 W AC PSUs. If you install the 600/900 W AC PSU in a chassis other than the BlackDiamond 8806, ExtremeXOS provides enough power to boot-up the chassis, display a warning message in the log, and disable the PSU. If this occurs, you see a message similar to the following:

```
<Warn:HAL.Sys.Warning>MSM-A:Power supply in slot 6 is not supported and is being disabled.
```

When a combination of 700/1200 W AC PSUs and 600/900 W AC PSUs are powered on in the same BlackDiamond 8806 chassis, all 700/1200 W AC PSUs are budgeted “down” to match the lower powered 600/900 W AC output values to avoid PSU shutdown. For more information about the 600/900 W AC PSU, refer to the hardware documentation which is listed in the Preface.

This section describes the following power management topics:

- [Initial System Boot Up on page 93](#)
- [Power Redundancy on page 94](#)
- [Power Management Guidelines on page 95](#)
- [Overriding Automatic Power Supply Management on page 96](#)

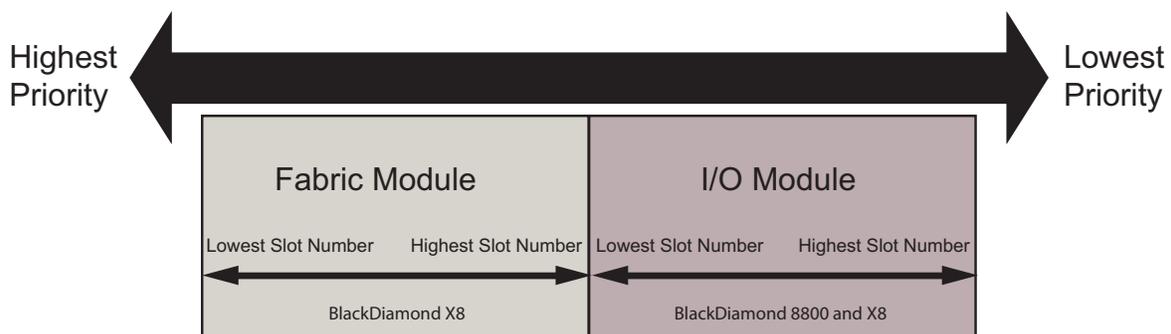
Initial System Boot Up

When ExtremeXOS boots up, it reads and analyzes the installed I/O modules (BlackDiamond 8800 and X8) and Fabric modules (BlackDiamond X8 series only). ExtremeXOS prioritizes the powering up of modules as follows (see [Figure 1](#)):

- BlackDiamond X8: Fabric modules are considered first for power up from the lowest numbered slot to the highest numbered slot, based on their power requirements and the available system power. I/O modules are then given priority from lowest numbered slot to highest numbered slot.
- BlackDiamond 8800 series: I/O modules are considered for power up from the lowest numbered slot to the highest numbered slot, based on their power requirements and the available system power.

If the system does not have enough power, some modules are not powered up.

Figure 1: I/O and Fabric Module Power Priority



For example, ExtremeXOS:

- Collects information about the PSUs installed to determine how many are running and how much power each can supply.
- Checks for PSU failures.

- Calculates the number of Fabric (BlackDiamond X8 only) and I/O modules to power up based on the available power budget and the power requirements of each I/O module, including PoE requirements for the BlackDiamond 8000 series PoE I/O module.
- Reserves the amount of power required to power up a second MSM/MM if only one MSM/MM is installed.
- Reserves the amount of power required to power all fans and chassis components.
- Calculates the current power surplus or shortfall.
- Logs and sends SNMP traps for transitions in the overall system power status, including whether the available amount of power is:
 - Redundant or N+1—Power from a single PSU can be lost and no I/O or Fabric (BlackDiamond X8 only) modules are powered down.
 - Sufficient, but not redundant—Power from a single PSU is lost, and one or more I/O modules (and then Fabric modules, for BlackDiamond X8 only) are powered down.
 - Insufficient—One or more modules are not powered up due to a shortfall of available power.

For the order of module priority during power-up, see [Figure 1](#),

By reading the PSU information, ExtremeXOS determines the power status and the total amount of power available to the system. The total power available determines which I/O and Fabric (BlackDiamond X8 series only) modules can be powered up.

Power Redundancy

In simple terms, power redundancy (N+1) protects the system from shutting down. With redundancy, if the output of one PSU is lost for any reason, the system remains fully powered. In this scenario, N is the minimum number of power supplies needed to keep the system fully powered and the system has N+1 PSUs powered.

If the system power status is not redundant, the removal of one PSU, the loss of power to one PSU, or a degradation of input voltage results in insufficient power to keep all of the I/O and Fabric (BlackDiamond X8 series only) modules powered up. If there is not enough power, ExtremeXOS powers down the modules as follows:

- BlackDiamond X8: I/O modules from the highest numbered slot to lowest numbered slot are powered down, and then Fabric modules from the highest numbered slot to lowest numbered slot are powered down until the switch has enough power to continue operation (see [Figure 1](#)).
- BlackDiamond 8800 series: I/O modules from the highest numbered slot to lowest numbered slot are powered down until the switch has enough power to continue operation (see [Figure 1](#)).

If you install or provide power to a new PSU, modules powered down due to earlier insufficient power are considered for power up from the lowest slot number to the highest slot number, based on the module's power requirements (see [Figure 1](#)).

Whenever the system experiences a change in power redundancy, including a change in the total available power, degraded input voltage, or a return to redundant power, the switch sends messages to the syslog.

Power Management Guidelines

The following list describes some key issues to remember when identifying your power needs and installing PSUs:

- If you disable a slot, the module installed in that slot is always powered down regardless of the number of PSUs installed.
- If a switch has PSUs with a mix of both 220V AC and 110V AC inputs, ExtremeXOS maximizes system power by automatically taking one of two possible actions:
 - If all PSUs are enabled then all PSUs must be budgeted at 110V AC to prevent overload of PSUs with 110V AC inputs.

OR

- If the PSUs with 110V AC inputs are disabled, then the PSUs with 220V AC inputs can be budgeted with a higher output per PSU.

ExtremeXOS computes the total available power using both methods and automatically uses the PSU configuration that provides the greatest amount of power to the switch. [Table 16](#) and [Table 17](#) list combinations where ExtremeXOS maximizes system power by disabling the PSUs with 110V AC inputs. This can be overridden if desired, as described in [“Overriding Automatic Power Supply Management”](#) on page 96.

Table 16: BlackDiamond 8800 Series PSU Combinations Where 110V PSUs Are Disabled

Number of PSUs with 220V AC Inputs	Number of PSUs with 110V AC Inputs
2	1
3	1
3	2
4	1
4	2
5	1

Table 17: BlackDiamond X8 Series PSU Combinations Where 110V PSUs Are Disabled

Number of PSUs with 220V AC Inputs	Number of PSUs with 110V AC Inputs
1	1
2	1
3	1
3	2
4	1
4	2
4	3
5	1
5	2
5	3
6	1
6	2
7	1

For all other combinations of 220V AC and 110V AC PSUs, ExtremeXOS maximizes system power by enabling all PSUs and budgeting each PSU at 110V AC.

BlackDiamond 8806 switch only—When a combination of 700/1200 W AC PSUs and 600/900 W AC PSUs are powered on in the same BlackDiamond 8806 chassis, all 700/1200 W AC PSUs are budgeted “down” to match the lower powered 600/900 W AC output values to avoid PSU shutdown.

Overriding Automatic Power Supply Management

You can override automatic power supply management to enable a PSU with 110V AC inputs that ExtremeXOS disables if the need arises, such as for a planned maintenance of 220V AC circuits. If the combination of AC inputs represents one of those listed in [Table 16](#), you can turn on a disabled PSU using the following command:

```
configure power supply <ps_num> on
```



NOTE

If you override automatic power supply management, you may reduce the available power and cause one or more I/O modules to power down.

To resume using automatic power supply management on a PSU, use the `configure power supply <ps_num> {auto | on}` command. The setting for each PSU is stored as part of the switch configuration.

To display power supply status and power budget information, use the `show power` and `show power budget` commands.

Power Visualization

Power visualization periodically polls for input power usage. The poll interval is configurable. Whenever the power is increased or decreased by the configured threshold power value, then a specified action is initiated (e.g., a trap, log, or trap-and-log). The configurable parameters are:

- input power usage poll interval (in seconds)
- change action (log, trap, or log-and-trap)
- change threshold (power value in watts)

In the stacking case, the Master periodically polls the power usage of all the PSUs in the stack and sends the log or trap or both, depending on the specified change action. Configuration commands are synchronized between Master and backup.

If the change-action is configured as trap or log-and-trap then the power usage trap is sent to the configured SNMP servers.

To configure power visualization, use the following command:

```
configure power monitor poll-interval [off | <seconds>] change-action [none | [log | log-and-trap | trap] change-threshold <watts>]
```

Note that the default poll interval is 60 seconds, and the default change action is none (input power usage values are only estimates).

Using Power Supplies—Summit Family Switches Only

On Summit family switches, ExtremeXOS reports when the PSU has power or has failed. The Summit family switches support an internal power supply with a range of 90V to 240V AC power as well as an external redundant power supply. The Extreme Networks External Power System (EPS) allows you to add a redundant power supply to the Summit family switches to protect against a power supply failure. The EPS consists of a tray or module that holds the EPS power supplies.



NOTE

When an EPS-T tray with two EPS-160 PSUs is connected to a Summit family switch, the internal power supply will show as failed.

On non-PoE Summit switches, if you experience an internal PSU failure and do not have an external PSU installed, the switch powers down. If you experience a PSU failure and have an external PSU installed, the switch uses the external PSU to maintain power to the switch.

On PoE Summit switches, there are specific power budget requirements and configurations associated with PoE that are not described in this section. The PoE Summit switches respond to internal and external PSU failures based on your PoE configurations. For more information about configuring PoE on the Summit PoE switches, see [Chapter 10, “PoE.”](#)

For more information about Summit family switches and EPS, refer to the hardware documentation which is listed in the “Preface” chapter.

Using Power Supplies - SummitStack Only

Since the nodes have their own power supplies and since they cannot be shared, management is the same as it is for standalone Summit family switches. The only difference is that the power management commands have been centralized so that they can be issued from the primary node.

Displaying Power Supply Information

To display the status of the currently installed power supplies on all switches, use the following command:

```
show power {<ps_num>} {detail}
```

The detail option of this command shows power usage parameters on stacking and standalone Summit switches.

On modular switches, the following commands provide additional power supply information.

To view the system power status and the amount of available and required power, use the following command:

```
show power budget
```

To display the status of the currently installed power supply controllers on modular switches, use the following command:

```
show power controller {<num>}
```

Using Motion Detectors

On the Summit X670 switch, there is a motion detection system that controls whether the port LEDs are turned on or off. When the motion detector is enabled, the LEDs are turned on only when motion is detected. You can also configure the time in seconds that the LEDs stay on after motion is detected. When the motion detector is disabled, the LED are always turned on.

To configure the motion detector, use the following command:

```
configure power led motion-detector [disable | enable {timeout <seconds>}]
```

To show the status and timeout setting of the motion detector, use the following command:

```
show power led motion-detector
```

Using the Network Time Protocol

Network Time Protocol (NTP) is used for synchronizing time on devices across a network with variable latency (time delay). NTP provides a coordinated Universal Time Clock (UTC), the primary time standard by which the world regulates clocks and time. UTC is used by devices that rely on having a highly accurate, universally accepted time, and can synchronize computer clock times to a fraction of a millisecond. In a networked environment, having a universal time can be crucial. For example, the stock exchange and air traffic control use NTP to ensure accurate, timely data.

NTP uses a hierarchical, semi-layered system of levels of clock sources called a “stratum.” Each stratum is assigned a layer number starting with 0 (zero), with 0 meaning the least amount of delay. The stratum number defines the distance, or number of NTP hops away, from the reference clock. The lower the number, the closer the switch is to the reference clock. The stratum also serves to prevent cyclical dependencies in the hierarchy.

Simple Network Time Protocol (SNTP), as the name would suggest, is a simplified version of NTP that uses the same protocol, but without many of the complex synchronization algorithms used by NTP. SNTP is suited for use in smaller, less complex networks. For more information about SNTP see the section, [“Using the Simple Network Time Protocol” on page 116](#).

Limitations

The Extreme Networks implementation of NTP includes the following limitations:

- You can use only the default VR for NTP service.
- SNTP cannot be enabled at the same time NTP is enabled.
- The NTP multicast delivery mechanism is not supported.
- The NTP autokey security mechanism is not supported.
- The broadcast client option cannot be enabled on a per-VLAN basis.

NTP Server/Client

An NTP server provides clock information to NTP or SNTP clients. You can configure an NTP server as an NTP client to receive clock information from more reliable external NTP servers or a local clock. You can also build a hierarchical time distribution topology by using TCP/IP. The switch can work as both an NTP client and server at the same time to build a hierarchical clock distribution tree. This hierarchical structure eliminates the need for a centralized clock server and provides a highly available clock tree with minimal network load and overhead.

Use these commands to configure an NTP server:

```
configure ntp [server | peer] add [<ip_address> | <host_name>] {key <keyid>} {option
[burst | initial-burst]}
configure ntp restrict-list [add | delete] <network> <mask> [permit | deny]
```

Use this command to delete an NTP server:

```
configure ntp [server | peer] delete [<ip_address> | <host_name>]
```

Use these commands to display NTP server or client information:

```
show ntp
show ntp association [{<ip_address>} | {<host_name>}]
show ntp restrict-list {user | system | all}
show ntp sys-info
```

NTP Peer Support

An NTP peer is a member of a group of NTP servers. Normally, an NTP peer is used to synchronize clock information among a group of servers that serve as mutual backups for each other. Typically, core switches are configured as NTP peers, and an NTP server is configured as a core switch to an NTP client, aggregation switch, or edge switch. An NTP client can choose the most reliable clock from all servers that have a peer relationship with the client.

Use this commands to configure an NTP peer:

```
configure ntp [server | peer] add [<ip_address> | <host_name>] {key <keyid>} {option
[burst | initial-burst]}
```

Use this command to delete an NTP peer:

```
configure ntp [server | peer] delete [<ip_address> | <host_name>]
```

Use these commands to display an NTP peer:

```
show ntp
show ntp association [{<ip_address>} | {<host_name>}] statistics
show ntp sys-info
```

NTP Local Clock Support

A local clock serves as backup to distribute clock information internally when reliable external clock sources are not reachable. Assign a higher stratum value to the local clock to ensure that it is not selected when an external reliable clock source with a lower stratum number exists.

Use this command to configure a local clock:

```
configure ntp local-clock stratum <stratum_number>
```

Use this command to delete a local clock:

```
configure ntp local-clock none
```

Use these commands to display local clock information:

```
show ntp association [{"ip_address"} | {"host_name"}]
show ntp association [{"ip_address"} | {"host_name"}] statistics
```

NTP Broadcast Server Support

An NTP broadcast server sends periodic time updates to a broadcast address in a LAN. When a broadcast client is configured for NTP, that client can receive time information from the broadcasted NTP packets. Using broadcast packets can greatly reduce the NTP traffic on a network, especially in a network with many NTP clients.

To ensure that NTP broadcast clients get clock information from the correct NTP broadcast servers, with minimized risks from malicious NTP broadcast attacks, configure MD5 authentication on both the NTP broadcast server and NTP clients.

Use this command to configure an NTP broadcast server over a VLAN where NTP broadcast service is provided:

```
enable ntp {vlan} <vlan-name> broadcast-server {key <keyid>}
```

Use this command to delete an NTP broadcast server over a VLAN where NTP broadcast service is enabled:

```
disable ntp {vlan} <vlan-name> broadcast-server
```

Use this command to display an NTP broadcast server:

```
show ntp server
```

NTP Broadcast Client Support

An NTP client listens for NTP packets from an NTP broadcast server. To listen for network broadcast messages, enable an NTP broadcast client. This option is global (it cannot be enabled on a per-VLAN basis).

Use this command to configure an NTP broadcast client:

```
enable ntp broadcast-client
```

Use this command to delete an NTP broadcast client:

```
disable ntp broadcast-client
```

Use this command to display an NTP broadcast client:

```
show ntp sys-info
```

NTP Authentication

To prevent false time information from unauthorized servers, enable NTP authentication to allow an authenticated server and client to exchange time information. The currently supported authentication method is Message Digest 5 (MD5). First, enable NTP authentication globally on the switch. Then create an NTP authentication key configured as trusted, to check the encryption key against the key on the

receiving device before an NTP packet is sent. After configuration is complete, an NTP server, peer, and broadcast server can use NTP authenticated service.

Use these commands to enable or disable NTP authentication globally on the switch:

```
enable ntp authentication
disable ntp authentication
```

Use these commands to create or delete an MD5 key for NTP authentication:

```
create ntp key <keyid> md5 <key_string>
delete ntp key [<keyid> | all]
```

Use these commands to configure an MD5 key as trusted or not trusted:

```
configure ntp key <keyid> [trusted | not-trusted]
```

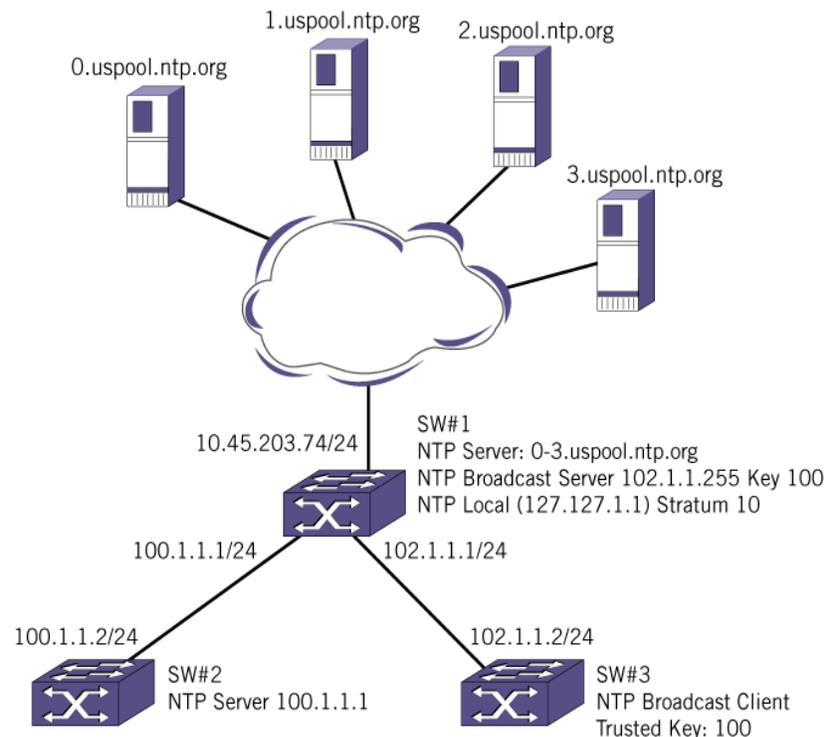
Use this command to display MD5 authentication:

```
show ntp key
```

NTP Configuration Example

In the example shown in [Figure 2](#), SW#1 synchronizes its clock from the 0-3.us.pool.ntp.org timer server, and provides the synchronized clock information to SW#2 as a unicast message, and to SW#3 as a broadcast message. SW#2 configures SW#1 as a time server using a normal unicast message. It also has a local clock (127.127.1.1) with a stratum level of 10. SW#3 is configured as broadcast client without specific server information. For security purposes, SW#2 and SW#3 use MD5 authentication with a key index of 100.

Figure 2: NTP Configuration Example



SW#1 Configuration

```
create vlan internet
create vlan toSW2
create vlan toSW3
config vlan internet add port 1
config vlan toSW2 add port 2
config vlan toSW3 add port 3
config vlan internet ipaddress 10.45.203.74/24
config vlan toSW2 ipaddress 100.1.1.1/24
config vlan toSW3 ipaddress 102.1.1.1/24
config iproute add default 10.45.203.1 vr vr-default

enable ntp
create ntp key index 100 md5 EXTREME
configure ntp key index 100 trusted
enable ntp vlan internet
enable ntp vlan toSW2
enable ntp vlan toSW3
enable ntp vlan toSW3 broadcast-server key 100
config ntp server add 0.us.pool.ntp.org
config ntp server add 1.us.pool.ntp.org
config ntp server add 2.us.pool.ntp.org
config ntp server add 3.us.pool.ntp.org
config ntp local-clock stratum 10
```

SW#2 Configuration

```
create vlan toSW1
config vlan toSW1 add port 1
config vlan toSW1 ipaddress 100.1.1.2/24

enable ntp
enable ntp vlan toSW1
config ntp server add 100.1.1.1
```

SW#3 Configuration

```
create vlan toSW1
config vlan toSW1 add port 1
config vlan toSW1 ipaddress 102.1.1.2/24

enable ntp
enable ntp broadcast-client
create ntp key index 100 md5 EXTREME
configure ntp key index 100 trusted
enable ntp vlan toSW1
```

Using the Simple Network Management Protocol

Any network manager program running the Simple Network Management Protocol (SNMP) can manage the switch if the Management Information Base (MIB) is installed correctly on the management station. Each network manager program provides its own user interface to the management facilities.

**NOTE**

When using a network manager program to create a VLAN, Extreme Networks does not support the SNMP create and wait operation. To create a VLAN with SNMP, use the create and go operation.

The following sections describe how to get started if you want to use an SNMP manager. It assumes you are already familiar with SNMP management.

This section describes the following SNMP topics:

- [Enabling and Disabling SNMPv1/v2c and SNMPv3 on page 103](#)
- [Accessing Switch Agents on page 104](#)
- [Supported MIBs on page 105](#)
- [Configuring SNMPv1/v2c Settings on page 105](#)
- [Displaying SNMP Settings on page 106](#)
- [SNMPv3 on page 107](#)
- [Message Processing on page 108](#)
- [SNMPv3 Security on page 108](#)
- [SNMPv3 MIB Access Control on page 111](#)
- [SNMPv3 Notification on page 112](#)
- [Access Profile Logging for SNMP on page 115](#)

Enabling and Disabling SNMPv1/v2c and SNMPv3

ExtremeXOS can concurrently support SNMPv1/v2c and SNMPv3. The default is both types of SNMP enabled. Network managers can access the device with either SNMPv1/v2c methods or SNMPv3.

To allow support for all SNMP access, or SNMPv1/v2c access only, or SNMPv3 access only, use the following command:

```
enable snmp access {snmp-v1v2c | snmpv3}
```

To prevent support for all SNMP access, or SNMPv1/v2c access only, or SNMPv3 access only, use the following command:

```
disable snmp access {snmp-v1v2c | snmpv3}
```

Most of the commands that support SNMPv1/v2c use the keyword `snmp`; most of the commands that support SNMPv3 use the keyword `snmpv3`.

After a switch reboot, all slots must be in the “Operational” state before SNMP can manage and access the slots. To verify the current state of the slot, use the `show slot` command.

Understanding Safe Defaults Mode and SNMP

The safe defaults mode runs an interactive script that allows you to enable or disable SNMP, Telnet, and switch ports. When you set up your switch for the first time, you must connect to the console port to access the switch. After logging in to the switch, you enter safe defaults mode. Although SNMP, Telnet, and switch ports are enabled by default, the script prompts you to confirm those settings.

If you choose to keep the default setting for SNMP—the default setting is enabled—the switch returns the following interactive script:

```
Since you have chosen less secure management methods, please remember to increase
the security of your network by taking the following actions:
```

- * change your admin password
- * change your SNMP public and private strings
- * consider using SNMPv3 to secure network management traffic

For more detailed information about safe defaults mode, see [“Safe Defaults Setup Method” on page 51](#).

Enabling and Disabling SNMP Access on Virtual Routers.

Beginning with ExtremeXOS 12.4.2 software, you can enable and disable SNMP access on any or all VRs. By default, SNMP access is enabled on all VRs.

When SNMP access is disabled on a VR, incoming SNMP requests are dropped and the following message is logged:

```
SNMP is currently disabled on VR <vr_name> Hence dropping the SNMP requests on this
VR.
```

To enable SNMP access on a VR, use the following command:

```
enable snmp access vr [<vr_name> | all]
```

To disable SNMP access on a VR, use the following command:

```
disable snmp access vr [<vr_name> | all]
```

To display the SNMP configuration and statistics on a VR, use the following command:

```
show snmp {vr} <vr_name>
```

SNMP access for a VR has global SNMP status that includes all SNMPv1v2c, SNMPv3 default users and default group status. However, trap receiver configuration and trap enabling/disabling are independent of global SNMP access and are still forwarded on a VR that is disabled for SNMP access.

Accessing Switch Agents

To access the SNMP agent residing in the switch, at least one VLAN must have an assigned IP address. ExtremeXOS supports either IPv4 or IPv6 addresses to manage the switch.

By default, SNMP access and SNMPv1/v2c traps are enabled. SNMP access and SNMP traps can be disabled and enabled independently—you can disable SNMP access but still allow SNMP traps to be sent, or vice versa.

Supported MIBs

In addition to private MIBs, the switch supports the standard MIBs listed in [Appendix E, “Supported Standards, Protocols, and MIBs.”](#)

Configuring SNMPv1/v2c Settings

The following SNMPv1/v2c parameters can be configured on the switch:

- **Authorized trap receivers**—An authorized trap receiver can be one or more network management stations on your network. The switch sends SNMPv1/v2c traps to all configured trap receivers. You can specify a community string and UDP port individually for each trap receiver. All community strings must also be added to the switch using the `configure snmp add community` command.

To configure a trap receiver on a switch, use the following command:

o

To configure the notification type (trap/inform), use the following command specifying `trap` as the type:

```
configure snmpv3 add notify [[hex <hex_notify_name>] | <notify_name>] tag [[hex <hex_tag>] | <tag>] {type [trap | inform]}{volatile}
```

To delete a trap receiver on a switch, use the following command:

```
configure snmp delete trapreceiver [[<ip_address> | <ipv6_address>] {<port_number>} | all]
```

Entries in the trap receiver list can also be created, modified, and deleted using the RMON2 trapDestTable MIB table, as described in RFC 2021.

- **SNMP INFORM**—SNMP INFORM allows for confirmation of a message delivery. When an SNMP manager receives an INFORM message from an SNMP agent, it sends a confirmation response back to the agent. If the message has not been received and therefore no response is returned, the INFORM message is resent. You can configure the number of attempts to make and the interval between attempts.

To configure the notification type (trap/inform), use the following command specifying `inform` as the type:

```
configure snmpv3 add notify [[hex <hex_notify_name>] | <notify_name>] tag [[hex <hex_tag>] | <tag>] {type [trap | inform]}{volatile}
```

To configure the number of SNMP INFORM notification retries, use the following command:

```
configure snmpv3 target-addr [[hex <hex_addr_name>] | <addr_name>] retry <retry_count>
```

To configure the SNMP INFORM timeout interval, use the following command:

```
configure snmpv3 target-addr [[hex <hex_addr_name>] | <addr_name>] timeout <timeout_val>
```

- **Community strings**—The community strings allow a simple method of authentication between the switch and the remote network manager. There are two types of community strings on the switch:
 - Read community strings provide read-only access to the switch. The default read-only community string is *public*.
 - Read-write community strings provide read- and-write access to the switch. The default read-write community string is *private*.

To store and display the SNMP community string in encrypted format, use the following command:

```
configure snmpv3 add community [[hex <hex_community_index>] | <community_index>]
[encrypted name <community_name> | name [[hex <hex_community_name>] |
<community_name>] {store-encrypted} ] user [[hex <hex_user_name>] | <user_name>]
{tag [[hex <transport_tag>] | <transport_tag>]} {volatile}
```

- **System contact** (optional)—The system contact is a text field that enables you to enter the name of the person(s) responsible for managing the switch.
- **System name** (optional)—The system name enables you to enter a name that you have assigned to this switch. The default name is the model name of the switch (for example, BD-1.2).
- **System location** (optional)—Using the system location field, you can enter the location of the switch.

Displaying SNMP Settings

To display the SNMP settings configured on the switch, use the following command:

```
show management
```

This command displays the following information:

- Enable/disable state for Telnet and SNMP access
- Login statistics
 - Enable/disable state for idle timeouts
 - Maximum number of CLI sessions
- SNMP community strings
- SNMP notification type (trap or INFORM)
- SNMP trap receiver list
- SNMP trap receiver source IP address
- SNMP statistics counter
- SSH access states of enabled, disabled, and module not loaded
- CLI configuration logging
- SNMP access states of v1, v2c disabled and v3 enabled
- Enable/disable state for Remote Monitoring (RMON)
- Access-profile usage configured via ACLs for additional Telnet and SSH2 security

- CLI scripting settings
 - Enable/disable state
 - Error message setting
 - Persistence mode
- Dropped SNMP packet counter.

SNMPv3

SNMPv3 is an enhanced standard for SNMP that improves the security and privacy of SNMP access to managed devices and provides sophisticated control of access to the device MIB. The prior standard versions of SNMP, SNMPv1, and SNMPv2c, provided no privacy and little security.

The following RFCs provide the foundation for the Extreme Networks implementation of SNMPv3:

- RFC 3410, *Introduction to version 3 of the Internet-standard Network Management Framework*, provides an overview of SNMPv3.
- RFC 3411, *An Architecture for Describing SNMP Management Frameworks*, talks about SNMP architecture, especially the architecture for security and administration.
- RFC 3412, *Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)*, talks about the message processing models and dispatching that can be a part of an SNMP engine.
- RFC 3413, *SNMPv3 Applications*, talks about the different types of applications that can be associated with an SNMPv3 engine.
- RFC 3414, *The User-Based Security Model for Version 3 of the Simple Network Management Protocol (SNMPv3)*, describes the User-Based Security Model (USM).
- RFC 3415, *View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)*, talks about VACM as a way to access the MIB.
- RFC 3826 - The Advanced Encryption Standard (AES) Cipher Algorithm in the SNMP User-based Security Model



NOTE

3DES, AES 192 and AES 256 bit encryption are proprietary implementations and may not work with some SNMP Managers.

The SNMPv3 standards for network management were driven primarily by the need for greater security and access control. The new standards use a modular design and model management information by cleanly defining a message processing (MP) subsystem, a security subsystem, and an access control subsystem.

The MP subsystem helps identify the MP model to be used when processing a received Protocol Data Unit (PDU), which are the packets used by SNMP for communication. The MP layer helps in implementing a multilingual agent, so that various versions of SNMP can coexist simultaneously in the same network.

The security subsystem features the use of various authentication and privacy protocols with various timeliness checking and engine clock synchronization schemes. SNMPv3 is designed to be secure against:

- Modification of information, where an in-transit message is altered
- Masquerades, where an unauthorized entity assumes the identity of an authorized entity

- Message stream modification, where packets are delayed and/or replayed
- Disclosure, where packet exchanges are sniffed (examined) and information is learned about the contents

The access control subsystem provides the ability to configure whether access to a managed object in a local MIB is allowed for a remote principal. The access control scheme allows you to define access policies based on MIB views, groups, and multiple security levels.

In addition, the SNMPv3 target and notification MIBs provide a more procedural approach for generating and filtering of notifications.

SNMPv3 objects are stored in non-volatile memory unless specifically assigned to volatile storage. Objects defined as permanent cannot be deleted.



NOTE

In SNMPv3, many objects can be identified by a human-readable string or by a string of hexadecimal octets. In many commands, you can use either a character string, or a colon-separated string of hexadecimal octets to specify objects. To indicate hexadecimal octets, use the keyword `hex` in the command.

Message Processing

A particular network manager may require messages that conform to a particular version of SNMP. The choice of the SNMPv1, SNMPv2c, or SNMPv3 MP model can be configured for each network manager as its target address is configured. The selection of the MP model is configured with the `mp-model` keyword in the following command:

```
configure snmpv3 add target-params [[hex <hex_param_name>] | <param_name>] user [[hex
<hex_user_name>] | <user_name>] mp-model [snmpv1 | snmpv2c | snmpv3] sec-model [snmpv1
| snmpv2c | usm] {sec-level [noauth | authnopriv | priv]} {volatile}
```

SNMPv3 Security

In SNMPv3 the User-Based Security Model (USM) for SNMP was introduced. USM deals with security related aspects like authentication, encryption of SNMP messages, and defining users and their various access security levels. This standard also encompasses protection against message delay and message replay.

USM Timeliness Mechanisms

An Extreme Networks switch has one SNMPv3 engine, identified by its *snmpEngineID*. The first four octets are fixed to 80:00:07:7C, which represents the Extreme Networks vendor ID. By default, the additional octets for the *snmpEngineID* are generated from the device MAC address.

Every SNMPv3 engine necessarily maintains two objects: *SNMPEngineBoots*, which is the number of reboots the agent has experienced and *SNMPEngineTime*, which is the local time since the engine reboot. The engine has a local copy of these objects and the *latestReceivedEngineTime* for every authoritative engine it wants to communicate with. Comparing these objects with the values received in messages and then applying certain rules to decide upon the message validity accomplish protection against message delay or message replay.

In a chassis, the `snmpEngineID` is generated using the MAC address of the MSM/MM with which the switch boots first. In a SummitStack, the MAC address chosen for the `snmpEngineID` is the configured stack MAC address.

The `snmpEngineID` can be configured from the command line, but when the `snmpEngineID` is changed, default users revert back to their original passwords/keys, and non-default users are reset to the security level of no authorization, no privacy. To set the `snmpEngineID`, use the following command:

```
configure snmpv3 engine-id <hex_engine_id>
```

`SNMPEngineBoots` can also be configured from the command line. `SNMPEngineBoots` can be set to any desired value but will latch on its maximum, 2147483647. To set the `SNMPEngineBoots`, use the following command:

```
configure snmpv3 engine-boots <(1-2147483647)>
```

Users, Groups, and Security

SNMPv3 controls access and security using the concepts of users, groups, security models, and security levels.

Users. Users are created by specifying a user name. Depending on whether the user will be using authentication and/or privacy, you would also specify an authentication protocol (MD5 or SHA) with password or key, and/or privacy (DES, 3DES, AES) password or key.

Before using the AES, 3DES users, you must install the SSH module and restart the `snmpMaster` process. Refer to “[Installing a Modular Software Package](#)” on page 1483 for information on installing the SSH module.

To create a user, use the following command:

```
configure snmpv3 add user [[hex <hex_user_name>] | <user_name>] {authentication [md5 | sha] [hex <hex_auth_password> | <auth_password>]} {privacy {des | 3des | aes {128 | 192 | 256}} [[hex <hex_priv_password>] | <priv_password>]} {volatile}
```

A number of default users are initially available. These user names are: `admin`, `initial`, `initialmd5`, `initialsha`, `initialmd5Priv`, `initialshaPriv`. The default password for `admin` is `password`. For the other default users, the default password is the user name.

To display information about a user, or all users, use the following command:

```
show snmpv3 user {[[hex <hex_user_name>] | <user_name>]}
```

Enabling the SNMPv3 default-user access allows an end user to access the MIBs using SNMPv3 default-user. To enable default-user, use the following command:

```
enable snmpv3 default-user
```

By disabling default-users access, the end-user is not able to access the switch/MIBs using SNMPv3 default-user. To disable default-user, use the following command:

```
disable snmpv3 default-user
```

To delete a user, use the following command:

```
configure snmpv3 delete user [all-non-defaults | [[hex <hex_user_name>] | <user_name>]]
```

**NOTE**

The SNMPv3 specifications describe the concept of a security name. In the ExtremeXOS implementation, the user name and security name are identical. In this manual, both terms are used to refer to the same thing.

Groups. Groups are used to manage access for the MIB. You use groups to define the security model, the security level, and the portion of the MIB that members of the group can read or write. To underscore the access function of groups, groups are defined using the following command:

```
configure snmpv3 add access [[hex <hex_group_name>] | <group_name>] {sec-model [snmpv1
| snmpv2c | usm]} {sec-level [noauth | authnopriv | priv]} {read-view [[hex
<hex_read_view_name>] | <read_view_name>]} {write-view [[hex <hex_write_view_name>]] |
<write_view_name>]} {notify-view [[hex <hex_notify_view_name>] | <notify_view_name>]}
{volatile}
```

The security model and security level are discussed in “[Security Models and Levels](#)” on page 111. The view names associated with a group define a subset of the MIB (subtree) that can be accessed by members of the group. The read view defines the subtree that can be read, write view defines the subtree that can be written to, and notify view defines the subtree that notifications can originate from. MIB views are discussed in “[SNMPv3 MIB Access Control](#)” on page 111.

A number of default groups are already defined. These groups are: *admin*, *initial*, *v1v2c_ro*, *v1v2c_rw*. To display information about the access configuration of a group or all groups, use the following command:

```
show snmpv3 access {[[hex <hex_group_name>] | <group_name>]}
```

Enabling SNMPv3 default-group access activates the access to an SNMPv3 default group and the user-created SNMPv3-user part of default group. To enable default-group, use the following command:

```
enable snmpv3 default-group
```

Disabling SNMPv3 default-group access removes access to default-users and user-created users who are part of the default-group. The user-created authenticated SNMPv3 users (who are part of a user-created group) are able to access the switch. To disable a default-group, use the following command:

```
disable snmpv3 default-group
```

Users are associated with groups using the following command:

```
configure snmpv3 add group [[hex <hex_group_name>] | <group_name>] user [[hex
<hex_user_name>] | <user_name>] {sec-model [snmpv1 | snmpv2c | usm]} {volatile}
```

To show which users are associated with a group, use the following command:

```
show snmpv3 group {[[hex <hex_group_name>] | <group_name>] {user [[hex
<hex_user_name>] | <user_name>}]}}
```

To delete a group, use the following command:

```
configure snmpv3 delete access [all-non-defaults | {[[hex <hex_group_name>] |
<group_name>] {sec-model [snmpv1 | snmpv2c | usm] sec-level [noauth | authnopriv |
priv]}]]}
```

When you delete a group, you do not remove the association between the group and users of the group. To delete the association between a user and a group, use the following command:

```
configure snmpv3 delete group {[[hex <hex_group_name>] | <group_name>]} user [all-non-
defaults | {[[hex <hex_user_name>] | <user_name>] {sec-model [snmpv1|snmpv2c|usm]}]]}
```

Security Models and Levels. For compatibility, SNMPv3 supports three security models:

- SNMPv1—no security
- SNMPv2c—community strings-based security
- SNMPv3—USM security

The default is USM. You can select the security model based on the network manager in your network.

The three security levels supported by USM are:

- noAuthnoPriv—No authentication, no privacy. This is the case with existing SNMPv1/v2c agents.
- AuthnoPriv—Authentication, no privacy. Messages are tested only for authentication.
- AuthPriv—Authentication, privacy. This represents the highest level of security and requires every message exchange to pass the authentication and encryption tests.

When a user is created, an authentication method is selected, and the authentication and privacy passwords or keys are entered.

When MD5 authentication is specified, HMAC-MD5-96 is used to achieve authentication with a 16-octet key, which generates a 128-bit authorization code. This authorization code is inserted in the msgAuthenticationParameters field of SNMPv3 PDUs when the security level is specified as either AuthnoPriv or AuthPriv. Specifying SHA authentication uses the HMAC-SHA protocol with a 20-octet key for authentication.

For privacy, the user can select any one of the following supported privacy protocols: DES, 3DES, AES 128/192/256. In the case of DES, a 16-octet key is provided as input to DES-CBS encryption protocol which generates an encrypted PDU to be transmitted. DES uses bytes 1-7 to make a 56 bit key. This key (encrypted itself) is placed in msgPrivacyParameters of SNMPv3 PDUs when the security level is specified as AuthPriv.

SNMPv3 MIB Access Control

SNMPv3 provides a fine-grained mechanism for defining which parts of the MIB can be accessed. This is referred to as the View-Based Access Control Model (VACM).

MIB views represent the basic building blocks of VACM. They are used to define a subset of the information in the MIB. Access to read, to write, and to generate notifications is based on the relationship between a MIB view and an access group. The users of the access group can then read, write, or receive notifications from the part of the MIB defined in the MIB view as configured in the access group.

A view name, a MIB subtree/mask, and an inclusion or exclusion define every MIB view. For example, there is a *System* group defined under the MIB-2 tree. The Object Identifier (OID) for MIB-2 is 1.3.6.1.2, and the *System* group is defined as MIB-2.1.1, or directly as 1.3.6.1.2.1.1.

To define a MIB view which includes only the *System* group, use the following subtree/mask combination:

```
1.3.6.1.2.1.1/1.1.1.1.1.1.0
```

The mask can also be expressed in hex notation (this is used for the ExtremeXOS CLI):

```
1.3.6.1.2.1.1/fe
```

To define a view that includes the entire MIB-2, use the following subtree/mask:

```
1.3.6.1.2.1.1/1.1.1.1.1.0.0.0
```

which, in the CLI, is:

```
1.3.6.1.2.1.1/f8
```

When you create the MIB view, you can choose to include the MIB subtree/mask or to exclude the MIB subtree/mask. To create a MIB view, use the following command:

```
configure snmpv3 add mib-view [[hex <hex_view_name>] | <view_name>] subtree
<object_identifier> {/<subtree_mask>} {type [included | excluded]} {volatile}
```

After the view has been created, you can repeatedly use the `configure snmpv3 add mib-view` command to include and/or exclude MIB subtree/mask combinations to precisely define the items you want to control access to.

In addition to the user-created MIB views, there are three default views. They are *defaultUserView*, *defaultAdminView*, and *defaultNotifyView*. To show MIB views, use the following command:

```
show snmpv3 mib-view [[hex <hex_view_name>] | <view_name>] {subtree
<object_identifier>}}
```

To delete a MIB view, use the following command:

```
configure snmpv3 delete mib-view [all-non-defaults | [[hex <hex_view_name>] |
<view_name>] {subtree <object_identifier>}}
```

MIB views that are used by security groups cannot be deleted.

SNMPv3 Notification

SNMPv3 can use either SNMPv1 traps or SNMPv2c notifications to send information from an agent to the network manager. The terms trap and notification are used interchangeably in this context. Notifications are messages sent from an agent to the network manager, typically in response to some state change on the agent system. With SNMPv3, you can define precisely which traps you want sent, to which receiver by defining filter profiles to use for the notification receivers.

To configure notifications, you configure a target address for the target that receives the notification, a target parameters name, and a list of notification tags. The target parameters specify the security and MP models to use for the notifications to the target. The target parameters name also points to the filter profile used to filter the notifications. Finally, the notification tags are added to a notification table so that any target addresses using that tag will receive notifications.

Target Addresses

A target address is similar to the earlier concept of a trap receiver. To configure a target address, use the following command:

```
configure snmpv3 add target-addr [[hex <hex_addr_name>] | <addr_name>] param [[hex
<hex_param_name>] | <param_name>] ipaddress [ [ <ip_address> | <ip_and_tmask> ] | [
<ipv6_address> | <ipv6_and_tmask> ]] {transport-port <port_number>} {from
[<src_ip_address> | <src_ipv6_address>]} {vr <vr_name>} {tag-list <tag_list>}
{volatile}
```

In configuring the target address you supply an address name that identifies the target address, a parameters name that indicates the MP model and security for the messages sent to that target address,

and the IP address and port for the receiver. The parameters name also is used to indicate the filter profile used for notifications. The target parameters is discussed in “[Target Parameters](#)” next.

The `from` option sets the source IP address in the notification packets.

The `tag-list` option allows you to associate a list of tags with the target address. The tag `defaultNotify` is set by default. Tags are discussed in the section “[Notification Tags](#)”.

To display target addresses, use the following command:

```
show snmpv3 target-addr {[hex <hex_addr_name>] | <addr_name>]}
```

To delete a single target address or all target addresses, use the following command:

```
configure snmpv3 delete target-addr {[hex <hex_addr_name>] | <addr_name>} | all]
```

Target Parameters

Target parameters specify the MP model, security model, security level, and user name (security name) used for messages sent to the target address. See “[Message Processing](#)” on page 108 and “[Users, Groups, and Security](#)” on page 109 for more details on these topics. In addition, the target parameter name used for a target address points to a filter profile used to filter notifications. When you specify a filter profile, you associate it with a parameter name, so you must create different target parameter names if you use different filters for different target addresses.

To create a target parameter name and to set the message processing and security settings associated with it, use the following command:

```
configure snmpv3 add target-params [[hex <hex_param_name>] | <param_name>] user [[hex <hex_user_name>] | <user_name>] mp-model [snmpv1 | snmpv2c | snmpv3] sec-model [snmpv1 | snmpv2c | usm] {sec-level [noauth | authnopriv | priv]} {volatile}
```

To display the options associated with a target parameters name or all target parameters names, use the following command:

```
show snmpv3 target-params {[hex <hex_target_params>] | <target_params>]}
```

To delete one or all the target parameters, use the following command:

```
configure snmpv3 delete target-params {[hex <hex_param_name>] | <param_name>} | all]
```

Filter Profiles and Filters

A filter profile is a collection of filters that specifies which notifications should be sent to a target address. A filter is defined by a MIB subtree and mask and by whether that subtree and mask is included or excluded from notification.

When you create a filter profile, you are associating only a filter profile name with a target parameter name. The filters that make up the profile are created and associated with the profile using a different command.

To create a filter profile, use the following command:

```
configure snmpv3 add filter-profile [[hex <hex_profile_name>] | <profile_name>] param [[hex <hex_param_name>]] | <param_name> {volatile}
```

After the profile name has been created, you associate filters with it using the following command:

```
configure snmpv3 add filter [[hex <hex_profile_name>] | <profile_name>] subtree
<object_identifier> {/<subtree_mask>} type [included | excluded] {volatile}
```

The MIB subtree and mask are discussed in “SNMPv3 MIB Access Control” on page 111, as filters are closely related to MIB views. You can add filters together, including and excluding different subtrees of the MIB until your filter meets your needs.

To display the association between parameter names and filter profiles, use the following command:

```
show snmpv3 filter-profile {[[hex <hex_profile_name>] | <profile_name>]} {param [[hex
<hex_param_name>] | <param_name>]}
```

To display the filters that belong a filter profile, use the following command:

```
show snmpv3 filter {[[hex <hex_profile_name>] | <profile_name>]} {{subtree}
<object_identifier>}
```

To delete a filter or all filters from a filter profile, use the following command:

```
configure snmpv3 delete filter [all | [[hex <hex_profile_name>] | <profile_name>]
{subtree <object_identifier>}]
```

To remove the association of a filter profile or all filter profiles with a parameter name, use the following command:

```
configure snmpv3 delete filter-profile [all | [[hex <hex_profile_name>] |
<profile_name>] {param [[hex <hex_param_name>] | <param_name>}]
```

Notification Tags

When you create a target address, either you associate a list of notification tags with the target or by default, the *defaultNotify* tag is associated with the target. When the system generates notifications, only those targets associated with tags currently in the standard MIB table, called *snmpNotifyTable*, are notified.

To add an entry to the table, use the following command:

```
configure snmpv3 add notify [[hex <hex_notify_name>] | <notify_name>] tag [[hex
<hex_tag>] | <tag>] {type [trap | inform]}{volatile}
```

Any targets associated with tags in the *snmpNotifyTable* are notified, based on the filter profile associated with the target.

To display the notifications that are set, use the following command:

```
show snmpv3 notify {[[hex <hex_notify_name>] | <notify_name>]}
```

To delete an entry from the *snmpNotifyTable*, use the following command:

```
configure snmpv3 delete notify {[[hex <hex_notify_name>] | <notify_name>]} | all-non-
defaults]
```

Configuring Notifications

Because the target parameters name points to a number of objects used for notifications, configure the target parameter name entry first. You can then configure the target address, filter profiles and filters, and any necessary notification tags.

Access Profile Logging for SNMP

The access profile logging feature allows you to use an ACL policy file or dynamic ACL rules to control access to SNMP services on the switch. When access profile logging is enabled for SNMP, the switch logs messages and increments counters when packets are denied access to SNMP. No messages are logged for permitted access.

You can manage SNMP access using one (not both) of the following methods:

- Create and apply an ACL policy file
- Define and apply individual ACL rules

One advantage of ACL policy files is that you can copy the file and use it on other switches. One advantage to applying individual ACL rules is that you can enter the rules at the CLI command prompt, which can be easier than opening, editing, and saving a policy file.

The following sections provide additional information on access profile logging for SNMP:

- [ACL Match Conditions and Actions on page 115](#)
- [Limitations on page 115](#)
- [Managing ACL Policies for SNMP on page 116](#)
- [Managing ACL Rules for SNMP on page 116](#)
- [Misconfiguration Error Messages on page 116](#)

ACL Match Conditions and Actions

Chapter 18, “ACLs,” describes how to create ACL policies and rules using match conditions and actions. Access profile logging supports the following match conditions and actions:

- Match conditions
 - Source-address—IPv4 and IPv6
- Actions
 - Permit
 - Deny

If the ACL is created with more match conditions or actions, only those listed above are used for validating the packets. All other conditions and actions are ignored.

The *source-address* field allows you to identify an IPv4 address, IPv6 address, or subnet mask for which access is either permitted or denied.

Limitations

This feature has the following limitations:

- Either policy files or ACL rules can be associated with SNMP, but not both at the same time.
- Only source-address match is supported.
- Access-lists that are associated with one or more applications (SNMP or Telnet, for example) cannot be directly deleted. They must be unconfigured from the application first and then deleted from the CLI.
- Default counter support is added only for ACL rules and not for policy files. For policy files you must configure count action.

Managing ACL Policies for SNMP

Chapter 18, “ACLs,” describes how to create ACL policy files. To configure SNMP to use an ACL policy, use one of the following commands:

```
configure snmp access-profile <profile_name>
configure snmp access-profile <profile_name> readonly
configure snmp access-profile <profile_name> readwrite
```

By default, SNMP supports the `readwrite` option. However, you can specify the `readonly` or `readwrite` option to change the current configuration.

To configure SNMP to remove a previously configured ACL policy, use the following command:

```
configure snmp access-profile none
```

Managing ACL Rules for SNMP

Before you can assign an ACL rule to SNMP, you must create a dynamic ACL rule as described in Chapter 18, “ACLs.” To add or delete a rule for SNMP access, use the following command:

```
configure snmp access-profile [ <access_profile> {readonly | readwrite} | [[add <rule>
] [first | [[before | after] <previous_rule>]]] | delete <rule> | none ]
```

To display the access-list permit and deny statistics for an application, use the following command:

```
show access-list counters process [snmp | telnet | ssh2 | http]
```

Misconfiguration Error Messages

The following messages can appear during configuration of policies or rules for the SNMP service:

- Rule <rule> is already applied
A rule with the same name is already applied to this service.
- Please remove the policy <policy> already configured, and then add rule <rule>
A policy file is already associated with the service. You must remove the policy before you can add a rule.
- Rule <previous_rule> is not already applied
The specified rule has not been applied to the service, so you cannot add a rule in relation to that rule.
- Rule <rule> is not applied
The specified rule has not been applied to the service, so you cannot remove the rule from the service.
- Error: Please remove previously configured rule(s) before configuring policy <policy>
A policy or one or more ACL rules are configured for the service. You must delete the remove the policy or rules from the service before you can add a policy.

Using the Simple Network Time Protocol

ExtremeXOS supports the client portion of the Simple Network Time Protocol (SNTP) Version 3 based on RFC1769. SNTP can be used by the switch to update and synchronize its internal clock from a

Network Time Protocol (NTP) server. After SNTP has been enabled, the switch sends out a periodic query to the indicated NTP server, or the switch listens to broadcast NTP updates. In addition, the switch supports the configured setting for Greenwich Mean time (GMT) offset and the use of Daylight Saving Time.

Configuring and Using SNTP

To use SNTP:

- 1 Identify the host(s) that are configured as NTP server(s). Additionally, identify the preferred method for obtaining NTP updates. The options are for the NTP server to send out broadcasts or for switches using NTP to query the NTP server(s) directly. A combination of both methods is possible. You must identify the method that should be used for the switch being configured.
- 2 Configure the Greenwich Mean Time (GMT) offset and Daylight Saving Time preference. The command syntax to configure GMT offset and usage of Daylight Saving Time is as follows:

```
configure timezone {name <tz_name>} <GMT_offset>
{autodst {name <dst_timezone_ID>} {<dst_offset>}}
{begins [every <floatingday> | on <absoluteday>] {at <time_of_day_hour>
<time_of_day_minutes>}}
{ends [every <floatingday> | on <absoluteday>] {at <time_of_day_hour>
<time_of_day_minutes>}}
```

By default beginning in 2007, Daylight Saving Time is assumed to begin on the second Sunday in March at 2:00 AM, and end the first Sunday in November at 2:00 AM and to be offset from standard time by one hour. If this is the case in your time zone, you can set up automatic daylight saving adjustment with the command:

```
configure timezone <GMT_offset> autodst
```

If your time zone uses starting and ending dates and times that differ from the default, you can specify the starting and ending date and time in terms of a floating day, as follows:

```
configure timezone name MET 60 autodst name MDT begins every last sunday march at
1 30 ends every last sunday october at 1 30
```

You can also specify a specific date and time, as shown in the following command:

```
configure timezone name NZST 720 autodst name NZDT 60 begins every first sunday
october at 2 00 ends on 3 16 2004 at 2 00
```

The optional time zone IDs are used to identify the time zone in display commands such as `show switch {detail}`.

[Table 18](#) describes the command options in detail.

Table 18: Time Zone Configuration Command Options

tz_name	Specifies an optional name for this timezone specification. May be up to six characters in length. The default is an empty string.
GMT_offset	Specifies a Greenwich Mean Time (GMT) offset, in + or - minutes.
autodst	Enables automatic Daylight Saving Time.
dst_timezone_ID	Specifies an optional name for this Daylight Saving Time specification. May be up to six characters in length. The default is an empty string.
dst_offset	Specifies an offset from standard time, in minutes. Value is in the range of 1 to 60. Default is 60 minutes.

Table 18: Time Zone Configuration Command Options (Continued)

floatingday	<p>Specifies the day, week, and month of the year to begin or end Daylight Saving Time each year. Format is:</p> <p><week> <day> <month> where:</p> <ul style="list-style-type: none"> • <week> is specified as [first second third fourth last] • <day> is specified as [sunday monday tuesday wednesday thursday friday saturday] • <month> is specified as [january february march april may june july august september october november december] <p>Default for beginning is second sunday march; default for ending is first sunday november.</p>
absoluteday	<p>Specifies a specific day of a specific year on which to begin or end DST. Format is:</p> <p><month> <day> <year> where:</p> <ul style="list-style-type: none"> • <month> is specified as 1-12 • <day> is specified as 1-31 • <year> is specified as 1970 - 2035 <p>The year must be the same for the begin and end dates.</p>
time_of_day_hour	Specifies the time of day to begin or end Daylight Saving Time. May be specified as an hour (0-23). Default is 2.
time_of_day_minutes	Specify the minute to begin or end Daylight Saving Time. May be specified as a minute (0-59).
noautodst	Disables automatic Daylight Saving Time.

Automatic Daylight Saving Time changes can be enabled or disabled. The default setting is enabled. To disable automatic Daylight Saving Time, use the command:

```
configure timezone {name <tz_name>} <GMT_offset> noautodst
```

3 Enable the SNTP client using the following command:

```
enable sntp-client
```

After SNTP has been enabled, the switch sends out a periodic query to the NTP servers defined in step 4 (if configured) or listens to broadcast NTP updates from the network. The network time information is automatically saved into the onboard real-time clock.

4 If you would like this switch to use a directed query to the NTP server, configure the switch to use the NTP server(s). An NTP server can be an IPv4 address or an IPv6 address or a hostname. If the switch listens to NTP broadcasts, skip this step. To configure the switch to use a directed query, use the following command:

```
configure sntp-client [primary | secondary] <host-name-or-ip> {vr <vr_name>}
```

The following two examples use an IPv6 address as an NTP server and a hostname as an NTP server:

```
configure sntp-client primary fd98:d3e2:f0fe:0:54ae:34ff:fecc:892
configure sntp-client primary ntpserver.mydomain.com
```

NTP queries are first sent to the primary server. If the primary server does not respond within 1 second, or if it is not synchronized, the switch queries the secondary server (if one is configured). If the switch cannot obtain the time, it restarts the query process. Otherwise, the switch waits for the sntp-client update interval before querying again.

- 5 Optionally, the interval for which the SNTP client updates the real-time clock of the switch can be changed using the following command:

```
configure sntp-client update-interval <update-interval>
```

The default `sntp-client update-interval` value is 64 seconds.

- 6 You can verify the configuration using the following commands:

```
- show sntp-client
```

This command provides configuration and statistics associated with SNTP and its connectivity to the NTP server.

```
- show switch {detail}
```

This command indicates the GMT offset, the Daylight Saving Time configuration and status, and the current local time.

NTP updates are distributed using GMT time. To properly display the local time in logs and other time-stamp information, the switch should be configured with the appropriate offset to GMT based on geographical location. [Table 19](#) lists GMT offsets.

Table 19: Greenwich Mean Time Offsets

GMT Offset in Hours	GMT Offset in Minutes	Common Time Zone References	Cities
+0:00	+0	GMT - Greenwich Mean UT or UTC - Universal (Coordinated) WET - Western European	London, England; Dublin, Ireland; Edinburgh, Scotland; Lisbon, Portugal; Reykjavik, Iceland; Casablanca, Morocco
-1:00	-60	WAT - West Africa	Cape Verde Islands
-2:00	-120	AT - Azores	Azores
-3:00	-180		Brasilia, Brazil; Buenos Aires, Argentina; Georgetown, Guyana
-4:00	-240	AST - Atlantic Standard	Caracas; La Paz
-5:00	-300	EST - Eastern Standard	Bogota, Columbia; Lima, Peru; New York, NY, Trevor City, MI USA
-6:00	-360	CST - Central Standard	Mexico City, Mexico
-7:00	-420	MST - Mountain Standard	Saskatchewan, Canada
-8:00	-480	PST - Pacific Standard	Los Angeles, CA, Santa Clara, CA, Seattle, WA USA
-9:00	-540	YST - Yukon Standard	
-10:00	-600	AHST - Alaska-Hawaii Standard CAT - Central Alaska HST - Hawaii Standard	
-11:00	-660	NT - Nome	
-12:00	-720	IDLW - International Date Line West	
+1:00	+60	CET - Central European FWT - French Winter MET - Middle European MEWT - Middle European Winter SWT - Swedish Winter	Paris France; Berlin, Germany; Amsterdam, The Netherlands; Brussels, Belgium; Vienna, Austria; Madrid, Spain; Rome, Italy; Bern, Switzerland; Stockholm, Sweden; Oslo, Norway

Table 19: Greenwich Mean Time Offsets (Continued)

GMT Offset in Hours	GMT Offset in Minutes	Common Time Zone References	Cities
+ 2:00	+120	EET - Eastern European, Russia Zone 1	Athens, Greece; Helsinki, Finland; Istanbul, Turkey; Jerusalem, Israel; Harare, Zimbabwe
+3:00	+180	BT - Baghdad, Russia Zone 2	Kuwait; Nairobi, Kenya; Riyadh, Saudi Arabia; Moscow, Russia; Tehran, Iran
+4:00	+240	ZP4 - Russia Zone 3	Abu Dhabi, UAE; Muscat; Tblisi; Volgograd; Kabul
+5:00	+300	ZP5 - Russia Zone 4	
+5:30	+330	IST - India Standard Time	New Delhi, Pune, Allahabad, India
+6:00	+360	ZP6 - Russia Zone 5	
+7:00	+420	WAST - West Australian Standard	
+8:00	+480	CCT - China Coast, Russia Zone 7	
+9:00	+540	JST - Japan Standard, Russia Zone 8	
+10:00	+600	EAST - East Australian Standard GST - Guam Standard Russia Zone 9	
+11:00	+660		
+12:00	+720	IDLE - International Date Line East NZST - New Zealand Standard NZT - New Zealand	Wellington, New Zealand; Fiji, Marshall Islands

SNTP Example

In this example, the switch queries a specific NTP server and a backup NTP server. The switch is located in Cupertino, California, and an update occurs every 20 minutes. The commands to configure the switch are as follows:

```
configure timezone -480 autodst
configure sntp-client update-interval 1200
enable sntp-client
configure sntp-client primary 10.0.1.1
configure sntp-client secondary 10.0.1.2
```

Using Auto Provision of Edge Switches

Auto provisioning allows you to configure certain parameters on a switch automatically using a DHCP and TFTP server. This process can make an Extreme Networks switch ready to do the initial provisioning without any manual intervention, resulting in time saving and efficiency.

The parameters that an auto-provision capable switch can obtain from a DHCP server and apply are as follows:

- IP address
- Gateway
- TFTP server to contact
- Configuration file to be loaded

A switch enabled with auto provision can be identified as follows:

- A warning message for the console and each Telnet session is displayed as follows:

Note: This switch has Auto-Provision enabled to obtain configuration remotely. Commands should be limited to:

```
show auto-provision
show log
```

Any changes to this configuration will be discarded at the next reboot if auto provisioning sends a ".cfg" file.

- The shell prompt reads as follows:
(auto-provision) X450a-24t.1 #
- The status is shown in the `show auto-provision` command.

The DHCP server can be any that provides the needed functionality. To obtain the desired parameters, the following DHCP options are used:

- Option 43 - vendor-encapsulated-options
- Option 60 - vendor-class-identifier. Extreme Networks switches use "Switch-type" as the option 60 parameter. You must configure this option on your DHCP server to provide the required attributes based on the specific model.

Following is a sample Linux DHCP configuration:

```
option space EXTREME;
option EXTREME.tftp-server-ip code 100 = ip-address;
option EXTREME.config-file-name code 101 = text;
option EXTREME.snmp-trap-ip code 102 = ip-address;

class "Edge-without-POE" {
    match if (option vendor-class-identifier = "X250e-48t");
    vendor-option-space EXTREME;
    option EXTREME.tftp-server-ip 10.120.89.80;
    option EXTREME.config-file-name "x250e_edge.cfg";
    option EXTREME.snmp-trap-ip 10.120.91.89;
}

class "Edge-x450e-POE" {
    match if (option vendor-class-identifier = "X450e-48p");
    vendor-option-space EXTREME;
    option EXTREME.tftp-server-ip 10.120.89.80;
    option EXTREME.config-file-name "x450e_edge.xsf";
    option EXTREME.snmp-trap-ip 10.120.91.89;
}
```

```
subnet 10.127.8.0 netmask 255.255.255.0 {
    option routers          10.127.8.254;
    option domain-name-servers 10.127.8.1;
    option subnet-mask      255.255.255.0;
    pool {
        deny dynamic bootp clients;

        range 10.127.8.170 10.127.8.190;

        allow members of "Edge-without-POE";

        allow members of "Edge-x450e-POE";
    }
}
```

Auto-provisioning Process

The auto-provisioning process is first initiated through the default VLAN (bound to *VR-Default*). After three unsuccessful attempts to reach the network, the switch waits for 15 seconds before it switches over to the Mgmt VLAN (bound to *VR-Mgmt*). It continues this process until it reaches the network.

Delay in the auto-provisioning process results from the following configuration problems:

- The DHCP server may not be reachable.
- The configuration file has an invalid file extension. Only `.cfg` or `.xsf` is accepted.
- The TFTP server is unreachable.
- The configuration file name does not exist in the TFTP server.

You can use the `show log` command to view the exact problem reported.

An SNMP trap is sent out for these conditions when the SNMP-Trap-IP code (code 102) is configured in the DHCP server. The SNMP trap is not sent out when the DHCP server is unreachable.

When these conditions occur, the switch continues to retry to reach the network and remains in an “In Progress” state.

When there is a system error or internal problem, the switch moves to an auto-provision “Failed” state. The switch does not retry the auto-provisioning process once it has reached the “Failed” state.

Once the network is reached, the switch receives and configures the IP address and the gateway. The switch then executes the configuration file (`.cfg` or `.xsf` file), sends the trap to inform the user of the successful auto-provisioning (only when the SNMP-Trap-IP code, code 102, is configured), and reboots for the new configuration to take effect.

Following is the mandatory DHCP option configuration used for auto provision to work:

Standard Option:

- 1 IP address
- 2 Subnet mask
- 3 Gateway

Option 60:

- 4 Vendor identifier option

Option 43:

- 5 TFTP server IP address
- 6 Configuration file name

Optional DHCP option

- 1 SNMP trap receiver IP address

**NOTE**

The file uploaded to the TFTP server using the `upload configuration <ipaddress> <filename>` command is an .xsf file extension configuration. An .cfg file extension configuration is created using the `tftp put <ip-address> <local_file>` command.

**NOTE**

Configuration changes made to the switch when auto provisioning is in progress will be appended if auto provisioning uses an .xsf file extension configuration, and it will be discarded if auto provisioning uses a .cfg file extension configuration.

Auto-provisioning Configuration

To enable auto provision, use the following command:

```
enable auto-provision
```

**NOTE**

Auto provisioning not enabled on the VLAN (Mgmt or Default) if the IP address is already configured.

To disable auto provision, use the following command:

```
disable auto-provision
```

When either an `enable auto-provision` or `disable auto-provision` command is issued, the following message is displayed:

This setting will take effect at the next reboot of this switch.

To display the current state of auto provision on the switch, use the following command:

```
show auto-provision
```

Access Profile Logging for HTTP/HTTPS

The access profile logging feature allows you to use an ACL policy file or dynamic ACL rules to control access to Hypertext Transfer Protocol (HTTP) services on the switch. When access profile logging is enabled for HTTP, the switch logs messages and increments counters when packets are denied access to HTTP. No messages are logged for permitted access.

**NOTE**

For more information on ExtremeXOS software support for HTTP, see [“Hypertext Transfer Protocol” on page 899](#).

You can manage HTTP access using one (not both) of the following methods:

- Create and apply an ACL policy file
- Define and apply individual ACL rules

One advantage of ACL policy files is that you can copy the file and use it on other switches. One advantage to applying individual ACL rules is that you can enter the rules at the CLI command prompt, which can be easier than opening, editing, and saving a policy file.

The following sections provide additional information on access profile logging for HTTP:

- [ACL Match Conditions and Actions on page 124](#)
- [Limitations on page 124](#)
- [Managing ACL Rules for HTTP on page 125](#)
- [Managing ACL Rules for HTTP on page 125](#)
- [Misconfiguration Error Messages on page 125](#)

ACL Match Conditions and Actions

Chapter 18, “ACLs,” describes how to create ACL policies and rules using match conditions and actions. Access profile logging supports the following match conditions and actions:

- Match conditions
 - Source-address—IPv4 and IPv6
- Actions
 - Permit
 - Deny

If the ACL is created with more match conditions or actions, only those listed above are used for validating the packets. All other conditions and actions are ignored.

The *source-address* field allows you to identify an IPv4 address, IPv6 address, or subnet mask for which access is either permitted or denied.

Limitations

This feature has the following limitations:

- Policy file support is not available for HTTP and HTTPS.
- Only source-address match is supported.
- Access-lists that are associated with one or more applications cannot be directly deleted. They must be unconfigured from the application first and then deleted from the CLI.

Managing ACL Rules for HTTP

Before you can assign an ACL rule to HTTP, you must create a dynamic ACL rule as described in [Chapter 18, “ACLs.”](#) To add or delete a rule for HTTP access, use the following command:

```
configure web http access-profile [[[add <rule> ] [first | [[before | after]
<previous_rule>]]] | delete <rule> | none ]
```

To display the access-list permit and deny statistics for an application, use the following command:

```
show access-list counters process [snmp | telnet | ssh2 | http]
```

Misconfiguration Error Messages

The following messages can appear during configuration of policies or rules for the SNMP service:

- Rule <rule> is already applied
A rule with the same name is already applied to this service.
- Please remove the policy <policy> already configured, and then add rule <rule>
A policy file is already associated with the service. You must remove the policy before you can add a rule.
- Rule <previous_rule> is not already applied
The specified rule has not been applied to the service, so you cannot add a rule in relation to that rule.
- Rule <rule> is not applied
The specified rule has not been applied to the service, so you cannot remove the rule from the service.
- Error: Please remove previously configured rule(s) before configuring policy <policy>
A policy or one or more ACL rules are configured for the service. You must delete the remove the policy or rules from the service before you can add a policy.

3

CHAPTER

Managing the ExtremeXOS Software

This chapter includes the following sections:

- [Overview on page 127](#)
- [Using the ExtremeXOS File System on page 128](#)
- [Managing the Configuration File on page 131](#)
- [Managing ExtremeXOS Processes on page 133](#)
- [Understanding Memory Protection on page 136](#)

Overview

The ExtremeXOS software platform is a distributed software architecture. The distributed architecture consists of separate binary images organized into discrete software modules with messaging between them. The software and system infrastructure subsystem form the basic framework of how the ExtremeXOS applications interact with each other, including the system startup sequence, memory allocation, and error events handling. Redundancy and data replication is a built-in mechanism of ExtremeXOS. The system infrastructure provides basic redundancy support and libraries for all of the ExtremeXOS applications.



NOTE

For information about downloading and upgrading a new software image, saving configuration changes, and upgrading the BootROM, see [Appendix B, “Software Upgrade and Boot Options.”](#)

Like any advanced operating system, ExtremeXOS gives you the tools to manage your switch and create your network configurations. With the introduction of ExtremeXOS, the following enhancements and functionality have been added to the switch operating system:

- File system administration
- Configuration file management
- Process control
- Memory protection

File system administration—With the enhanced file system, you can move, copy, and delete files from the switch. The file system structure allows you to keep, save, rename, and maintain multiple copies of

configuration files on the switch. In addition, you can manage other entities of the switch such as policies and access control lists (ACLs).

Configuration file management—With the enhanced configuration file management, you can oversee and manage multiple configuration files on your switch. In addition, you can upload, download, modify, and name configuration files used by the switch.

Process control—With process control, you can stop and start processes, restart failed processes, and update the software for a specific process or set of processes.

Memory protection—With memory protection, each function can be bundled into a single application module running as a memory protected process under real-time scheduling. In essence, ExtremeXOS protects each process from every other process in the system. If one process experiences a memory fault, that process cannot affect the memory space of another process.

The following sections describe in more detail how to manage the ExtremeXOS software.

Using the ExtremeXOS File System

The file system in ExtremeXOS is the structure by which files are organized, stored, and named. The switch can store multiple user-defined configuration and policy files, each with its own name.

Using a series of commands, you can manage the files on your system. For example, you can rename or copy a configuration file on the switch, display a comprehensive list of the configuration and policy files on the switch, or delete a policy file from the switch.



NOTE

Filenames are case-sensitive. For information on filename restrictions, refer to the specific command in the ExtremeXOS Command Reference Guide.

You can also download configuration and policy files from the switch to a network Trivial File Transfer Protocol (TFTP) server using TFTP. For detailed information about downloading switch configurations, see [Appendix B, “Software Upgrade and Boot Options.”](#) For detailed information about downloading policies and ACLs, see [Chapter 17, “Policy Manager.”](#)

With guidance from Extreme Networks Technical Support personnel, you can configure the switch to capture core dump files, which contain debugging information that is useful in troubleshooting situations. For more information about configuring core dump files and managing the core dump files stored on your switch, see [Appendix D, “Troubleshooting.”](#)

This section describes the following file management topics:

- [Moving or Renaming Files on the Switch on page 129](#)
- [Copying Files on the Switch on page 129](#)
- [Displaying Files on the Switch on page 130](#)
- [Transferring Files to and from the Switch on page 130](#)
- [Deleting Files from the Switch on page 131](#)

Moving or Renaming Files on the Switch

To move or rename an existing configuration, policy, or if configured, core dump file in the system, use the following command:

```
mv [internal-memory <old-name-internal> internal-memory <new-name-internal> |
internal-memory <old-name-internal> memorycard <new-name-memorycard> | memorycard
<old-name-memorycard> memorycard <new-name-memorycard> | memorycard <new-name-
memorycard> <new-name> | <old-name> memorycard <new-name-memorycard> | <old-name>
<new-name>]
```

XML-formatted configuration files have a .cfg file extension. The switch runs only .cfg files. ASCII-formatted configuration files have an .xsf file extension. See [“Uploading ASCII-Formatted Configuration Files” on page 1495](#) for more information. Policy files have a .pol file extension.

When you rename a file, make sure the renamed file uses the same file extension as the original file. If you change the file extensions, the file may be unrecognized by the system. For example, if you have an existing configuration file named *test.cfg*, the new filename must include the .cfg file extension.

When you rename a file on the switch, a message similar to the following appears:

```
Rename config test.cfg to config megtest.cfg on switch? (y/n)
```

Enter *y* to rename the file on your system. Enter *n* to cancel this process and keep the existing filename.

If you attempt to rename an active configuration file (the configuration currently selected the boot the switch), the switch displays an error similar to the following:

```
Error: Cannot rename current selected active configuration.
```

For more information about configuring core dump files and managing the core dump files stored on your switch, see [Appendix D, “Troubleshooting.”](#)

Copying Files on the Switch

The copy function allows you to make a copy of an existing file before you alter or edit the file. By making a copy, you can easily go back to the original file if needed.

To copy an existing configuration or policy file on your switch, use the following command:

```
cp [internal-memory <old-name-internal> internal-memory <new-name-internal> |
internal-memory <old-name-internal> memorycard <new-name-memorycard> | memorycard
<old-name-memorycard> memorycard <new-name-memorycard> | memorycard <old-name-
memorycard> <new-name> | <old-name> memorycard <new-name-memorycard> | <old-name>
<new-name>]
```

XML-formatted configuration files have a .cfg file extension. The switch runs .cfg files only. ASCII-formatted configuration files have an .xsf file extension. See [“Uploading ASCII-Formatted Configuration Files” on page 1495](#) for more information. Policy files have a .pol file extension.

When you copy a configuration or policy file from the system, make sure you specify the appropriate file extension. For example, if you want to copy a policy file, specify the filename and *.pol*.

When you copy a file on the switch, a message similar to the following appears:

```
Copy config test.cfg to config test1.cfg on switch? (y/n)
```

Enter *y* to copy the file. Enter *n* to cancel this process and not copy the file.

When you enter `y`, the switch copies the file with the new name and keeps a backup of the original file with the original name. After the switch copies the file, use the `ls` command to display a complete list of files.

**NOTE**

If you make a copy of a file, such as a core dump file, you can easily compare new information with the old file if needed.

For more information about configuring the storage of core dump files, see [Appendix D, “Troubleshooting.”](#)

Displaying Files on the Switch

To display a list of the configuration, policy, or if configured, core dump files stored on your switch, use the following command:

```
ls {[internal-memory | memorycard]} {<file-name>}
```

When you do not specify a parameter, this command lists all of the files stored on your switch.

Output from this command includes the file size, date and time the file was last modified, and the file name.

For more information about configuring core dump files and managing the core dump files stored on your switch, see [Appendix D, “Troubleshooting.”](#)

Transferring Files to and from the Switch

TFTP allows you to transfer files between a TFTP server and the following switch storage areas: local file system, internal memory card, compact flash card, and USB 2.0 storage device. To download a file from a TFTP server to the switch, use the `tftp` or `tftp get` commands:

- `tftp [<host-name> | <ip-address>] {-v <vr_name>} [-g | -p] [{-l [internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local-file>] {-r <remote-file>} | {-r <remote-file>} {-l [internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local-file>}]}`
- `tftp get [<host-name> | <ip-address>] {-vr <vr_name>} [{[internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local_file>] {<remote_file>} | {<remote_file>} {[internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local_file>}]}] {force-overwrite}`

**NOTE**

By default, if you transfer a file with a name that already exists on the system, the switch prompts you to overwrite the existing file. For more information, see the `tftp get` command in the *ExtremeXOS Command Reference Guide*.

To upload a file from the switch to a TFTP server, use the `tftp` or `tftp put` commands:

- `tftp [<host-name> | <ip-address>] {-v <vr_name>} [-g | -p] [{-l [internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local-file>} {-r <remote-file>} | {-r <remote-file>} {-l [internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local-file>}]}`
- `tftp put [<host-name> | <ip-address>] {-vr <vr_name>} [{[internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local_file>} {<remote_file>} | {<remote_file>} {[internal-memory <local-file-internal> | memorycard <local-file-memcard> | <local_file>}]}`

For more information about TFTP, see [Chapter 2, “Managing the Switch.”](#) For detailed information about downloading software image files, BootROM files, and switch configurations, see [Appendix B, “Software Upgrade and Boot Options.”](#) For more information about configuring core dump files and managing the core dump files stored on your switch, see [Appendix D, “Troubleshooting.”](#)

Deleting Files from the Switch

To delete a configuration, policy, or if configured, core dump file from your system, use the following command:

```
rm {internal-memory | memorycard} <file-name>
```

If you do not specify the internal memory card or a removable storage device, the switch downloads or uploads the file from the switch local file system.

When you delete a configuration or policy file from the system, make sure you specify the appropriate file extension. For example, when you want to delete a policy file, specify the filename and `.pol`. After you delete a file, it is unavailable to the system.

When you delete a file from the switch, a message similar to the following appears:

```
Remove testpolicy.pol from switch? (y/n)
```

Enter `y` to remove the file from your system. Enter `n` to cancel the process and keep the file on your system.

If you attempt to delete an active configuration file (the configuration currently selected to boot the switch), the switch displays an error similar to the following:

```
Error: Cannot remove current selected active configuration.
```

For more information about configuring core dump files and managing the core dump files stored on your switch, see [Appendix D, “Troubleshooting.”](#)

Managing the Configuration File

The configuration is the customized set of parameters that you have selected to run on the switch. [Table 20](#) describes some of the key areas of configuration file management in ExtremeXOS.

Table 20: Configuration File Management

Task	Behavior
Configuration file database	<p>ExtremeXOS supports saving a configuration file into any named file and supports more than two saved configurations.</p> <p>For example, you can download a configuration file from a network TFTP server and save that file as primary, secondary, or with a user-defined name. You also select where to save the configuration: primary or secondary partition, or another space.</p> <p>The file names primary and secondary exist for backward compatibility with ExtremeWare®.</p>
Downloading configuration files	<p>ExtremeXOS uses the <code>tftp</code> and <code>tftp get</code> commands to download configuration files from the network TFTP server to the switch.</p> <p>For more information about downloading configuration files, see “Using TFTP to Download the Configuration” on page 1499.</p>
Uploading configuration files	<p>ExtremeXOS uses the <code>tftp</code> and <code>tftp put</code> commands to upload configuration files from the switch to the network TFTP server.</p> <p>For more information about uploading configuration files, see “Using TFTP to Upload the Configuration” on page 1498.</p>
Managing configuration files, including listing, copying, deleting, and renaming	<p>The following commands allow you to manage configuration files:</p> <ul style="list-style-type: none"> • <code>ls</code>—Lists all of the configuration files in the system • <code>cp</code>—Makes a copy of an existing configuration file in the system • <code>rm</code>—Removes/deletes an existing configuration file from the system • <code>mv</code>—Renames an existing configuration file
Configuration file type	<p>ExtremeXOS configuration files are saved in Extensible Markup Language (XML) format. Use the <code>show configuration</code> command to view on the CLI your currently running switch configuration.</p>
ASCII-formatted configuration file	<p>You can upload your current configuration in ASCII format to a network TFTP server. The uploaded ASCII file retains the CLI format.</p> <p>To view your configuration in ASCII format, save the configuration with the <code>.xsf</code> file extension (known as the XOS CLI script file). This saves the XML-based configuration in an ASCII format readable by a text editor.</p> <p>ExtremeXOS uses the <code>upload configuration</code> command to upload the ASCII-formatted configuration file from the switch to the network TFTP server.</p> <p>ExtremeXOS uses the <code>tftp</code> and <code>tftp get</code> commands to download configuration files from the network TFTP server to the switch.</p> <p>For more information about ASCII-formatted configuration files, see “Uploading ASCII-Formatted Configuration Files” on page 1495.</p>
XML configuration mode	<p>Indicated by (xml) at the front of the switch prompt. Do not use. Use the command <code>disable xml-mode</code> to disable this mode.</p>
Displaying configuration files	<p>You can also see a complete list of configuration files by entering the <code>ls</code> command followed by the Tab key.</p>

For more information about saving, uploading, and downloading configuration files, see [“Saving the Configuration” on page 1497](#).

Managing ExtremeXOS Processes

ExtremeXOS consists of a number of cooperating processes running on the switch. With process control, under certain conditions, you can stop and start processes, restart failed processes, examine information about the processes, and update the software for a specific process or set of processes.

This section describes the following topics:

- [Displaying Process Information on page 133](#)
- [Stopping a Process on page 134](#)
- [Starting a Process on page 135](#)

Displaying Process Information

To display information about the processes in the system, use the following command:

```
show process {<name>} {detail} {description} {slot <slotid>}
```

Where the following is true:

- `name`—Specifies the name of the process.
- `detail`—Specifies more detailed process information, including memory usage statistics, process ID information, and process statistics.
- `description`—Describes the name of all of the processes or the specified process running on the switch.
- `slotid`—On a modular chassis, specifies the slot number of the MSM/MM. A specifies the MSM/MM installed in slot A. B specifies the MSM/MM installed in slot B. On a SummitStack, specifies the target node's slot number. The number is a value from 1 to 8. (This parameter is available only on modular switches and SummitStack.)

The `show process` and `show process slot <slotid>` commands display the following information in a tabular format:

- `Card`—The name of the module where the process is running (modular switches only).
- `Process Name`—The name of the process.
- `Version`—The version number of the process. Options are:
 - `Version number`—A series of numbers that identify the version number of the process. This is helpful to ensure that you have version-compatible processes and if you experience a problem.
 - `Not Started`—The process has not been started. This can be caused by not having the appropriate license or for not starting the process.
- `Restart`—The number of times the process has been restarted. This number increments by one each time a process stops and restarts.
- `State`—The current state of the process. Options are:
 - `No License`—The process requires a license level that you do not have. For example, you have not upgraded to that license, or the license is not available for your platform.
 - `Ready`—The process is running.
 - `Stopped`—The process has been stopped.

- **Start Time**—The current start time of the process. Options are:
 - **Day/Month/Date/Time/Year**—The date and time the process began. If a process terminates and restarts, the start time is also updated.
 - **Not Started**—The process has not been started. This can be caused by not having the appropriate license or for not starting the process.

When you specify the `detail` keyword, more specific and detailed process information is displayed. The `show process detail` and `show process slot <slotid> detail` commands display the following information in a multi-tabular format:

- Detailed process information
- Memory usage configurations
- Recovery policies
- Process statistics
- Resource usage

Stopping a Process

If recommended by Extreme Networks Technical Support personnel, you can stop a running process. To stop a running process, use the following command:

```
terminate process <name> [forceful | graceful] {msm <slot>}
```

In a SummitStack:

```
terminate process <name> [forceful | graceful] {slot <slot>}
```

Where the following is true:

- `name`—Specifies the name of the process.
- `forceful`—Specifies that the software quickly terminate a process. Unlike the `graceful` option, the process is immediately shutdown without any of the normal process cleanup.
- `graceful`—Specifies that the process shutdown gracefully by closing all opened connections, notifying peers on the network, and other types of process cleanup.
- `slot`—For a modular chassis, specifies the slot number of the MSM/MM. A specifies the MSM/MM installed in slot A. B specifies the MSM/MM installed in slot B. On a SummitStack, specifies the target node's slot number. The number is a value from 1 to 8. (This parameter is available only on modular switches and SummitStack.)



NOTE

Do not terminate a process that was installed since the last reboot unless you have saved your configuration. If you have installed a software module and you terminate the newly installed process without saving your configuration, your module may not be loaded when you attempt to restart the process with the `start process` command.

To preserve a process's configuration during a terminate and (re)start cycle, save your switch configuration before terminating the process. Do not save the configuration or change the configuration during the process terminate and re(start) cycle. If you save the configuration after terminating a process, and before the process (re)starts, the configuration for that process is lost.

You can also use a single command to stop and restart a running process during a software upgrade on the switch. By using the single command, there is less process disruption and it takes less time to stop

and restart the process. To stop and restart a process during a software upgrade, use the following command:

```
restart process [class <cname> | <name> {msm <slot>}]
```

Where the following is true:

- `cname`—Specifies that the software terminates and restarts all instances of the process associated with a specific routing protocol on all VRs.
- `name`—Specifies the name of the process.

Starting a Process

To start a process, use the following command:

```
start process <name> {msm <slot>}
```

In a SummitStack:

```
start process <name> {slot <slot>}
```

Where the following is true:

- `name`—Specifies the name of the process.
- `slot`—For a modular chassis, specifies the slot number of the MSM/MM. A specifies the MSM/MM installed in slot A. B specifies the MSM/MM installed in slot B. On a SummitStack, specifies the slot number of the target node. The number is a value from 1 to 8. (This parameter is available only on modular switches and SummitStack.)

You are unable to start a process that is already running. If you try to start a currently running process, for example *telnetd*, an error message similar to the following appears:

```
Error: Process telnetd already exists!
```



NOTE

After you stop a process, do not change the configuration on the switch until you start the process again. A new process loads the configuration that was saved prior to stopping the process. Changes made between a process termination and a process start are lost. Else, error messages can result when you start the new process.

As described in the section, “[Stopping a Process](#)” on page 134, you can use a single command, rather than multiple commands, to stop and restart a running process. To stop and restart a process during a software upgrade, use the following command:

```
restart process [class <cname> | <name> {msm <slot>}]
```

In a SummitStack:

```
restart process [class <cname> | <name> {slot <slot>}]
```

For more detailed information, see the previous section or the *ExtremeXOS Command Reference Guide*.

Understanding Memory Protection

ExtremeXOS provides memory management capabilities. With ExtremeXOS, each process runs in a protected memory space. This infrastructure prevents one process from overwriting or corrupting the memory space of another process. For example, if one process experiences a loop condition, is under some type of attack, or is experiencing some type of problem, that process cannot take over or overwrite another processes' memory space.

Memory protection increases the robustness of the system. By isolating and having separate memory space for each individual process, you can more easily identify the process or processes that experience a problem.

To display the current system memory and that of the specified process, use the following command:

```
show memory process <name> {slot <slotid>}
```

Where the following is true:

- `name`—Specifies the name of the process.
- `slot`—On a modular chassis, specifies the slot number of the MSM/MM. A specifies the MSM/MM installed in slot A. B specifies the MSM/MM installed in slot B. On a SummitStack, specifies the slot number of the target node. The number is a value from 1 to 8. (This parameter is available only on modular switches and SummitStack.)

The `show memory process` command displays the following information in a tabular format:

- System memory information (both total and free)
- Current memory used by the individual processes

The current memory statistics for the individual process also includes the following:

- The module (MSM A or MSM B) and the slot number of the MSM/MM (modular switches only)
- The name of the process

You can also use the `show memory {slot [slotid | a | b]}` command to view the system memory and the memory used by the individual processes, even for all processes on all MSMs/MMs installed in modular switches. The `slot` parameter is available only on modular switches and SummitStack.

In general, the `free` memory count for an MSM/MM or Summit family switch decreases when one or more running processes experiences an increase in memory usage. If you have not made any system configuration changes, and you observe a continued decrease in free memory, this might indicate a memory leak.

The information from these commands may be useful for your technical support representative if you experience a problem.

The following is sample truncated output from a Summit family switch:

CPU Utilization Statistics - Monitored every 25 seconds

```

-----
Process          5   10   30   1     5   30   1   Max     Total
                 secs secs secs min  mins mins hour   User/System
                 util util util util util util util util CPU Usage
                 (%)  (%)  (%)  (%)  (%)  (%)  (%)  (%)  (secs)
-----
System          n/a  n/a  0.0  0.9  0.1  0.2  0.5  34.6
aaa             n/a  n/a  0.0  0.0  0.0  0.0  0.0  1.8  1.72  0.78
acl            n/a  n/a  0.0  0.0  0.0  0.0  0.0  0.0  0.40  0.24
bgp            n/a  n/a  0.0  0.0  0.0  0.0  0.0  12.6  11.18  2.21
cfgmgr         n/a  n/a  0.0  0.0  0.0  0.0  0.8  39.8  4743.92  3575.79
cli            n/a  n/a  0.0  0.0  0.0  0.0  0.0  0.0  0.59  0.42
devmgr         n/a  n/a  0.0  0.0  0.0  0.0  0.0  19.5  74.44  24.52
dirser         n/a  n/a  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
dosprotect     n/a  n/a  0.0  0.0  0.0  0.0  0.0  0.0  0.8  0.12
eaps           n/a  n/a  0.0  0.0  0.0  0.0  0.1  5.5  36.40  15.41
edp            n/a  n/a  0.0  0.0  0.0  0.0  0.0  11.1  10.92  3.97
elrp           n/a  n/a  0.0  0.0  0.0  0.0  0.0  0.0  0.49  0.44
ems            n/a  n/a  0.0  0.0  0.0  0.0  0.0  0.0  1.19  1.29
epm            n/a  n/a  0.0  0.0  0.0  0.0  0.0  30.7  48.74  32.93
esrp           n/a  n/a  0.0  0.0  0.0  0.0  0.0  2.7  0.82  0.45
etmon          n/a  n/a  0.0  0.0  0.0  0.0  0.5  30.5  4865.78  873.87
...

```


4

CHAPTER

Configuring Stacked Switches

This chapter includes the following sections:

- [Overview on page 139](#)
- [Logging into a Stack on page 153](#)
- [Stack Configuration Guidelines on page 154](#)
- [Configuring a New Stack on page 158](#)
- [Converting a Standalone Node Deployment to a Stack on page 164](#)
- [Stack Configuration Tasks on page 166](#)
- [Managing an Operating Stack](#)
- [Troubleshooting a Stack on page 209](#)
- [FAQs on the SummitStack Feature on page 216](#)

Overview

The SummitStack™ feature allows you to physically connect up to eight individual Summit switches together as a single logical unit, which is called a *stack*. The stack behaves as a single switch with a single IP address and a single point of authentication.

In ExtremeXOS, a stack is controlled by a master switch, called the master. The master switch runs full ExtremeXOS and is responsible for maintaining all of the software tables for all the switches in the stack. There can only be one master switch in a stack. All switches in the stack, including the master switch, are called nodes.

A stack can be thought of as a virtual chassis. Each node acts as if it was occupying a slot in a chassis and is controlled by the master. The high-speed stacking links function like the backplane links of a chassis.

The master switch stores any configuration information for the stack in its primary and secondary flash memory. Since the master switch has the knowledge of the state and the configuration of all the other switches in the stack, it can respond to all external requests for those switches. For example, the master switch can respond to a request for SNMP information from all ports within the stack.

**NOTE**

The SummitStack feature is supported only on the platforms listed for this feature in the license tables in Appendix A, “Feature License Requirements.” All participants in a stack must run the same image version.

This section introduces the following SummitStack topics:

- [SummitStack Terms on page 140](#)
- [SummitStack Compatible Switches on page 143](#)
- [SummitStack Topologies on page 143](#)
- [Stack Depth on page 146](#)
- [Understanding Stack Configuration Parameters, Configuration Files, and Port Numbering on page 147](#)
- [Understanding Stacking Link Overcommitment on page 148](#)
- [About Stack Logging Messages on page 149](#)
- [About QoS in Stacking on page 149](#)
- [About Power Management and Power Over Ethernet on Stacking on page 151](#)
- [About Stacking Node Roles, Redundancy, and Failover on page 152](#)
- [About the Failsafe Account on SummitStack Nodes on page 152](#)

SummitStack Terms

Table 21 describes the terms used for the SummitStack feature. These terms are listed in the recommended reading sequence.

Table 21: List of Stacking Terms

Term	Description
Stackable Switch	A Summit family switch that provides two stacking ports and can participate in a stack.
Stacking Port	A physical interface of a stackable switch that is used to allow the connection of a stacking link. Stacking ports are point-to-point links that are dedicated for the purpose of forming a stack.
Native Port	A native port is a stacking port that can only be used for connections between stacked switches.
Alternate Port	An alternate port is a port that can be used for either stack connections or data connections.
Stacking Link	A wire that connects a stacking port of one stackable switch to a stacking port of another stackable switch, plus the stacking ports themselves.
Node	A node is a stackable switch that runs the ExtremeXOS operating system. The terms <i>node</i> and <i>stackable switch</i> are used interchangeably in this chapter.
Stack	A stack is a set of stackable switches and their connected stacking links made with the intentions that: (1) all switches are reachable through their common connections; (2) a single stackable switch can manage the entire stack; and (3) configurable entities such as VLANs and link trunk groups can have members on multiple stackable switches. A stack consists of all connected nodes regardless of the state of these nodes.
Stack Topology	A contiguously connected set of nodes in a stack that are currently communicating with one another. All nodes that appear in the <code>show stacking</code> command display are present in the stack topology.

Table 21: List of Stacking Terms (Continued)

Term	Description
Stack Path	A data path that is formed over the stacking links for the purpose of determining the set of nodes that are present in the stack topology and their locations in the stack. Every node is always present in a stack path whether or not stacking is enabled on the node.
Control Path	A data path that is formed over the stacking links that is dedicated to carrying control traffic, such as commands to program hardware or software image data for software upgrade. A node must <i>join</i> the control path to fully operate in the stack. A node that is disabled for stacking does not join the control path, but does communicate over the stack path.
Active Node	A node that has joined the control path. The active node can forward the control path messages or can process the control path messages. It can also forward data traffic. Only an active node can appear as a <i>card</i> inserted into a <i>slot</i> when the <code>show slot {<slot> {detail} detail }</code> command is executed on the master node of the stack.
Active Topology	<p>A contiguous set of active nodes in a stack topology plus the set of stacking links that connect them form the active topology. When an active topology consists of more than one node, each node in the active topology is directly and physically connected to at least one other node in the active topology. Thus, the active topology is a set of physically contiguous active nodes within a stack topology.</p> <div data-bbox="578 877 646 947" style="float: left; margin-right: 10px;"> </div> <p>NOTE</p> <p>A node in the stack topology may not necessarily be a member of the active topology.</p>
Candidate Node	A node that is a potential member of an active topology is called a <i>candidate</i> node. An active node is also a candidate node. Unlike an active node, a candidate node may not have joined the control path.
Node Role	A node in the active topology plays a role in the stack. There are three node roles: master (or primary), backup, and standby.
Master Node Role	<p>A node that is elected as the master (or primary) runs all of the configured control protocols such as OSPF, RIP, Spanning Tree, EAPS, and so forth.</p> <p>The master node controls all data ports on itself, the backup node, and all standby nodes. The master node issues specific programming commands over the control path to the backup or standby nodes to accomplish this purpose.</p>
Backup Node Role	The node that is operating in the backup node role takes over the master node role if the master node fails. The master node keeps the backup node databases in synchronization with its own database in preparation for this event. Upon transfer of role, the backup node becomes the master node and begins operating with the databases it has previously received. This allows all other nodes in the stack to continue operating even after the master node fails.
Standby Node Role	A node that is executing the standby node role is prepared to become a backup node in the event that the backup node becomes the master node. When becoming a backup node, the new master node synchronizes all of its databases to the new backup node. As a standby node, most databases are not synchronized, except for those few that directly relate to hardware programming.

Table 21: List of Stacking Terms (Continued)

Term	Description
Acquired Node	A standby or backup node is normally <i>acquired</i> by a master node. This means the master node has used its databases to program the hardware of the standby or backup node. The standby or backup node has acted as a hardware programming <i>proxy</i> , accepting the instructions of the master node to do so. An acquired standby node does not maintain the databases needed to reflect why the hardware is programmed as it is; however, a backup node does. An acquired node can only be re-acquired (without a reboot) by the backup node when that backup node becomes a master node, and only if both the backup and standby nodes were already acquired by the same master node at the time of its failure.
Data Ports	This is the set of ports provided by a stackable switch that are available to you for connection to your data networks. Such ports can be members of a user configured VLAN or trunk group, and can be used for Layer 2 and 3 forwarding of user data traffic or for mirroring, or other features you can configure. This term does not refer to stacking ports.
Failover	When a node that is executing the master node role in a stack fails, a failover is initiated. If there is a node that is executing the backup node role, and if the node has completed its initial synchronization with the master node before it failed, the backup node takes on the master node role. The standby nodes continue their operation, and their data ports do not fail.
Hitless Failover	A failover whereby all data ports in the stack, except those of the failing master node, continue normal operation when the master node fails.
Hitless Upgrade	This is an operation where an upgrade of the software image and the commencement of the new image execution is possible without interrupting data traffic or forcing any network reconvergence. This ExtremeXOS software version does not support hitless upgrade for a stack.
Node Address	Stacking nodes are uniquely identified by their <i>node address</i> . This is actually the MAC address that was factory assigned to each node.
Node Role Election	This is the process that determines the role for each node. The election takes place during initial stack startup and elects a master and a backup node. An election also takes place after a master node failover, when a new backup node is elected from the remaining standby nodes.
Node Role Election Priority	For each node, the stack computes a priority to be used in <i>node role election</i> . The node with the highest node role election priority during a role election becomes the master node. The node with the second highest node role election priority becomes the backup.
Operational Node	This is a node that has achieved operational state as a <i>card</i> in a <i>slot</i> . The operational state can be displayed using the <code>show slot <slot> {detail} detail</code> command.
System UpTime	This is the amount of time that has passed since a stack first elected a master node after the stack last rebooted. The time can be displayed on a master node by entering the <code>show switch {detail}</code> command.
Stack Segment	This is a collection of nodes that form a stack topology. The term is useful when a stack is severed. Each severed portion of the stack is referred to as a stack segment.
Stack State	A state assigned by the stack to a node. This can be displayed using the command <code>show stacking</code> .
Easy-Setup	Easy-setup is a procedure that configures the essential stack parameters of every node for initial stack deployment, and automatically reboots the stack to put the parameters into effect. The choice to run easy-setup is offered when the <code>enable stacking {node-address <node-address>}</code> command is run and the essential stacking parameters are unconfigured or inconsistent. It can also be invoked directly by running the <code>configure stacking easy-setup</code> command.

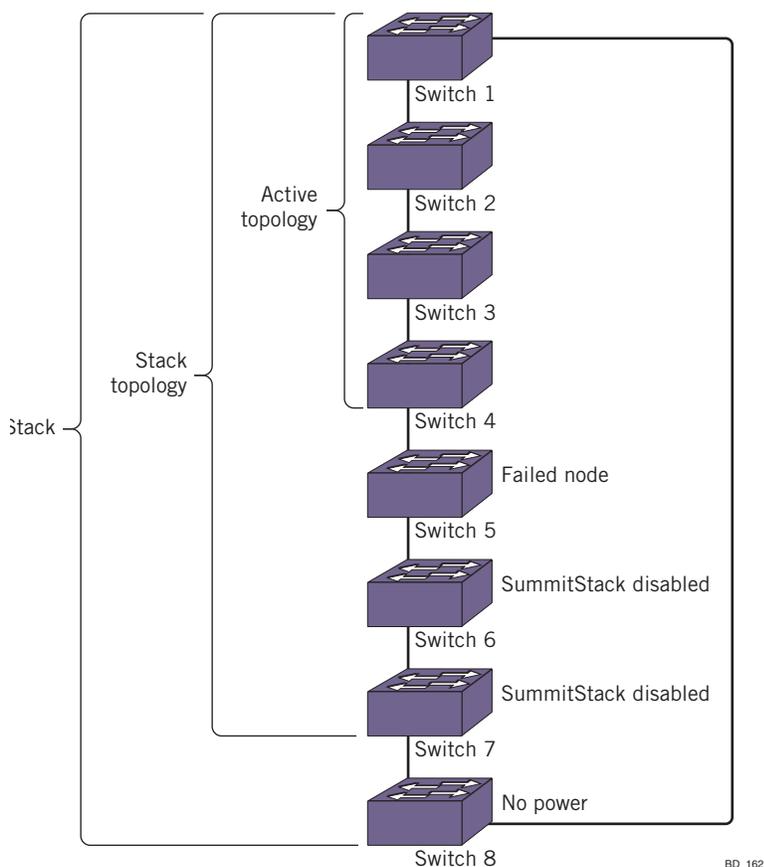
SummitStack Compatible Switches

Appendix A, “Feature License Requirements,” lists the platforms that are supported by the SummitStack feature.

SummitStack Topologies

Figure 3 presents a graphical representation of a stack and some of the terms that describe stack conditions.

Figure 3: Stack and Topologies



A stack is the collection of all nodes that are cabled together in a stack.

A stack topology is the set of contiguous nodes that are powered up and communicating with each other. Switch 8 is not part of the stack topology in Figure 3 because it is not powered up.

An active topology is the set of contiguous nodes that are active. An active node is powered up, configured for stack operation, and communicating with the other active nodes. Switch 5 in Figure 3 has failed, and stacking is disabled on Switch 6 and Switch 7. Switch 8 has no power, so the active topology includes switches: Switch 1, Switch 2, Switch 3, and Switch 4.

For more information on SummitStack terminology, see “SummitStack Terms” on page 140.

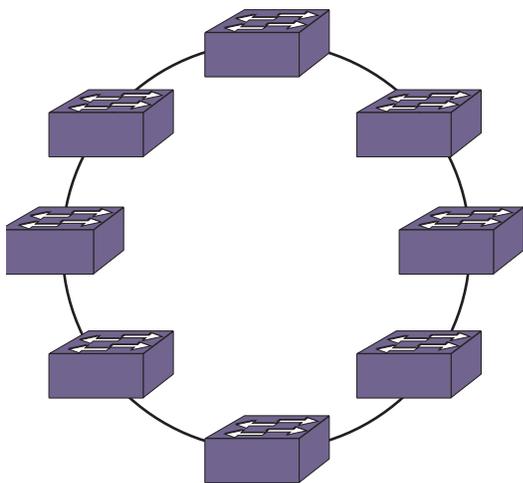
This section introduces the following topologies and topics:

- [Ring Topology on page 144](#)
- [Daisy Chain Topology on page 145](#)
- [Stack Depth on page 146](#)

Ring Topology

SummitStack nodes should be connected to each other in a ring topology. In a ring topology, one link is used to connect to a node and the other link is used to connect to another node. The result forms a physical ring connection. This topology is highly recommended for normal operation. [Figure 4](#) shows a maximal ring topology of eight active nodes.

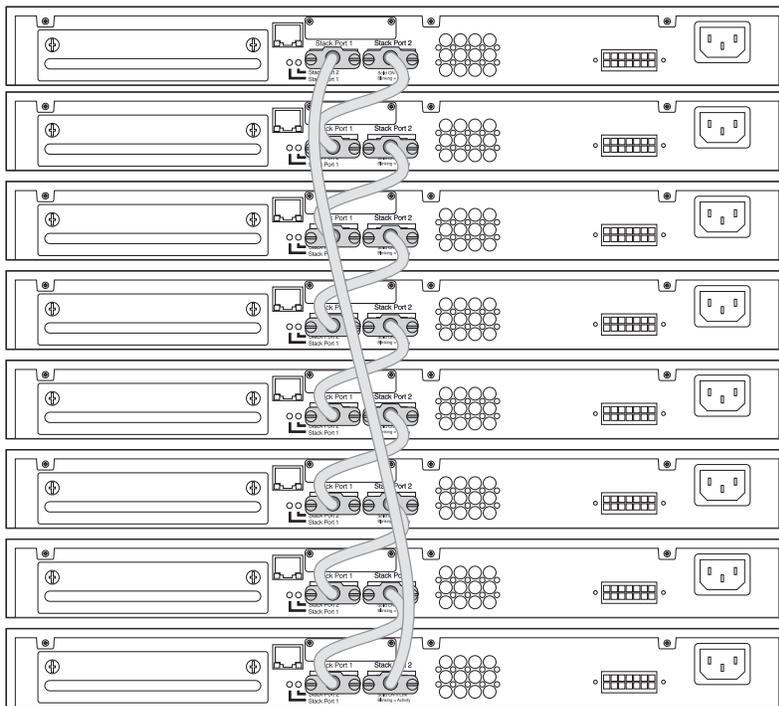
Figure 4: Graphical Representation of a Ring Topology



BD_163

While a physical ring connection may be present, a ring active topology only exists if all nodes in the stack are active nodes.

Figure 5: Summit Family Switches in a Ring Topology



BD_159A

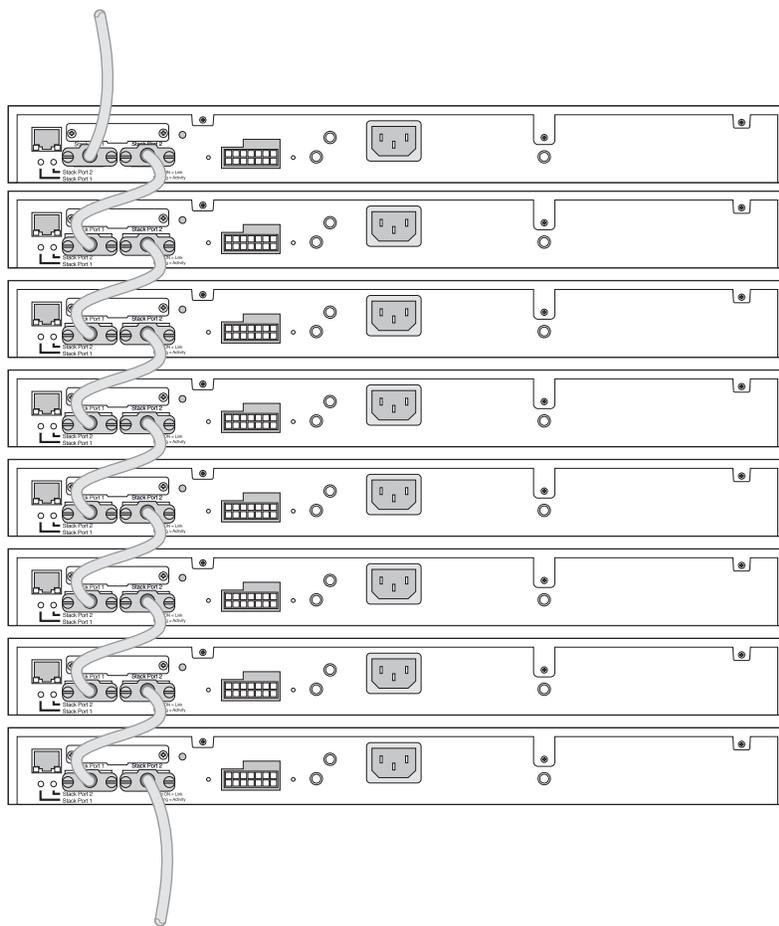
Daisy Chain Topology

The stackable switches may be connected in a daisy-chain topology. This is a ring topology with one of the links disconnected, inoperative, or disabled. A daisy chain can be created when a link fails or a node reboots in a ring topology, but the daisy chain topology is not recommended for normal operation. In [Figure 6](#), the nodes delineated as the *active topology* are operating in a daisy-chain configuration, even though there is physically a ring connection in the stack.



NOTE

The daisy chain topology is not recommended for normal operation.

Figure 6: X250 Series in Daisy-Chain Topology

BD_153A

You might need to use a daisy chain topology while adding a new node, removing a node, or while joining two stacks.

If you are using a daisy chain topology, the possibility of a dual master situation increases. So before you create a daisy chain topology, read [“Managing a Dual Master Situation”](#) on page 210.

**NOTE**

The maximum cable length supported between switches depends on the types of Summit family switches in your stack, the installed option cards, and the configured stack ports. For more information, see the *Summit Family Switches Hardware Installation Guide*.

Stack Depth

A maximum of eight (8) nodes are supported in the active topology. The slot number configuration assigns only numbers from one (1) to eight (8).

**NOTE**

When the VIM1-SummitStack512 option is installed in a Summit X650 switch, the Summit X650 switch can connect to only one other Summit X650 switch with an installed VIM1-SummitStack512. If you remove a cable between the two VIM1-SummitStack512 option cards, the stack fails. The cabling is unique to this back-to-back configuration and is described in the *Summit Family Switches Hardware Installation Guide*.

The stack tolerates an accidental connection of up to 17 nodes. Because only eight nodes can join an active topology, there should never be an accidental connection of two stacks resulting in more than 16 nodes. If you have more than 17 nodes in a stack topology, all nodes enter an *overflow state* and all stacking links enter a *link overflow state*. While in an overflow state, the active topology does not function. All slots containing active nodes show a *Failed state*. The overflow state is maintained until the overflow is cleared by manually disconnecting a sufficient number of nodes. After the overflow is cleared, all nodes in the stack topology reboot.

To see all the nodes in a stack topology, use the `show stacking` command.

Understanding Stack Configuration Parameters, Configuration Files, and Port Numbering

The stacking configurations are stored in the NVRAM of each node. Some of these configurations take effect only during the next node restart.

Table 22: Stacking Configuration Items, Time of Effect and Default Value

Configuration Item	Takes Effect	Default Value
Stacking Mode	at boot time	Disabled
Slot Number	at boot time	1
Master-Capable	at boot time	Yes
License Restriction	at boot time	Not configured
Priority	at the next master election	Automatic
Alternate IP Address	immediately	Not configured
Stack MAC	at boot time	Not configured
Stacking protocol	at boot time	Standard

Stacking parameters, such as mode, slot number, etc., can be configured from a single unit in the stack topology. You can change the stacking-specific configuration even when a node is not in stacking mode but is connected to the stack. The target node for the configuration must be powered on and running a version of ExtremeXOS that supports stacking. Further, the node need not be in stacking mode and can be in any node role.

Most ExtremeXOS configuration parameters are not stored in NVRAM, but are instead stored in a configuration file. Configurations stored in NVRAM are those that are needed when the configuration file is not available. The configuration file chosen for the stack is the one selected on the master node that is first elected after a stack restart.

The data (non-stacking) port numbers, in the existing configuration files (which were created when not in stacking mode), are simple integer quantities. On a stack, the data port numbers are expressed as slot:port; where the slot is an integer representing the slot and port is an integer representing the port.

For example: 1:2. The configuration file contains an indication that it was created on a stackable switch in stacking mode. The indication is the stacking platform ID.

Thus when in stacking mode, the ports are referenced in the configuration file with the slot:port notation and when not in stacking mode, the ports are referenced as simple integers.

When the stack restarts, if a switch becomes the master and its selected configuration file was not created in stacking mode, the configuration file is de-selected, and the stack completes its restart using a default configuration. In addition, if the previously selected file was named with one of the default names (*primary.cfg* or *secondary.cfg*), the file is renamed to *old_non_stack.cfg*.

Similarly, if a switch is configured not to operate in stacking mode and the selected configuration file was created in stacking mode, the configuration file is de-selected, and the switch boots with a default configuration. In addition, if the file was named with one of the default names (*primary.cfg* or *secondary.cfg*), the file is renamed to *old_stack.cfg*.

The renamed file replaces any file that exists with the same name; the existing file is deleted.

Understanding Stacking Link Overcommitment

The stack is formed by each node supplying a pair of full-duplex, logical stacking ports. Most Summit switches provide 2 physical stacking ports, but the Summit X650 switch with the VIM1-SummitStack512 option card provides 4 physical stacking ports that function as 2 logical stacking ports.

Each node can operate on a stack with full duplex throughput up to the following limits:

- 512 Gbps: Summit X650 switches with VIM1-SummitStack512 option card
- 256 Gbps: Summit X650 switches with VIM1-SummitStack256 option card
- 160 Gbps:
 - Summit X480 switches with VIM3-40G4X option card
 - Summit X650 switches with VIM3-40G4X option card
 - Summit X670V switches with VIM4-40G4X option card
- 128 Gbps: Summit X480 switches with VIM2-SummitStack128 option card
- 80 Gbps:
 - Summit X460 switches with SummitStack V80 option card
 - Summit X480 switches with VIM2-SummitStack-V80 option card
 - Summit X650 switches with VIM3-40G4X option card
 - Summit X670V switches with VIM4-40G4X option card
- 40 Gbps:
 - Summit X440 switches
 - Summit X460 switches with SummitStack option card
 - Summit X480 switches with VIM2-SummitStack
 - Summit X650 switches with VIM1-SummitStack or VIM1-10G8X option card
 - All other stackable Summit switches



NOTE

When the VIM1-SummitStack512 option is installed in a Summit X650 switch, the Summit X650 switch can connect to only one other Summit X650 switch with an installed VIM1-SummitStack512. If you remove a cable

between the two VIM1-SummitStack512 option cards, the stack fails. The cabling is unique to this back-to-back configuration and is described in the *Summit Family Switches Hardware Installation Guide*.

Even though two links are available, the links might not be fully utilized. For example, suppose there is a ring of eight nodes and the nodes are numbered clockwise from 1 to 8. The stacking port limit in this example is 10 Gbps in each direction for a total stack throughput of 20 Gbps for each port, or 40 Gbps total. Suppose node 1 wants to send 10 Gbps of unicast traffic to each of node 2 and node 3. The shortest path topology forces all traffic from node 1 over the link to node 2. Traffic from node 1 to node 3 passes through node 2. Thus, there is only 10 Gbps link available. However, if node 1 wanted to send 10 Gbps to node 2 and node 8, there would be 20 Gbps available because both links connected to node 1 would be used.

In a ring of eight nodes, between any two nodes (with one exception), only one link is used. If the devices provide 48 1Gbps Ethernet ports, the overcommitment ratio between two such nodes is approximately 5:1. The exception is if there is an equal distance between the nodes. In this case, if both nodes are 48-port nodes, the nodes are grouped into two groups of 24 ports (by the hardware architecture), and thus it is possible to use both directions around the stack.

About Stack Logging Messages

Each node can generate log messages through the usual logging mechanism.

On backup and standby nodes, a log target and related filter is automatically installed. The log target is the master node. The filter allows all messages that have a log level of warning, error, or critical to be saved in the log file of the master node.

If the master node changes, the log target is updated on all the remaining nodes.

You can also log in to any node in the active topology and see the complete log of the node.

About QoS in Stacking

Each stack uses QoS on the stacking links to prioritize the following traffic within the stack:

- Stack topology control packets
- ExtremeXOS control packets
- Data packets

For stack performance and reliability, the priority of control packets is elevated over that of data packets. This is done to prevent control packet loss and avoid the timed retries that can lower performance. It is also done to prevent unneeded stack topology changes that can occur if enough stack topology information packets are lost. For these reasons, the SummitStack feature reserves one QoS profile to provide higher priority to control packets. The following sections describe the differences in QoS while using it in stack:

- [QoS Profile Restrictions on page 150](#)
- [QoS Scheduler Operation on page 150](#)
- [Processing of Packets Received With 802.1p Priority 6 on page 150](#)
- [Effects on 802.1p Examination on page 150](#)
- [Effects on DiffServ Examination on page 151](#)
- [Effects on Port QoS and VLAN QoS on page 151](#)

QoS Profile Restrictions

In stacking mode, CoS level 6 (which is hardware queue 6) is reserved for stacking, so you cannot create quality profile QP7. Because QP7 cannot be created, you cannot use hardware queue 6 to assign CoS level 6 to a packet. However, you can assign packets received with 802.1p priority 6 to a QoS profile using the technique described in [“Processing of Packets Received With 802.1p Priority 6” on page 150](#).



NOTE

This restriction is applicable only when the stackable switch is operating in stacking mode.

QoS Scheduler Operation

In stacking mode, the QoS scheduler operation is different for the stacking ports and the data ports. The scheduler for the data ports operates the same as for standalone Summit family switches and is managed with the following command:

```
configure qosscheduler [strict-priority | weighted-round-robin | weighted-deficit-round-robin]
```

The scheduler for the stacking ports is defined by the software when the stack is configured, and it cannot be modified. For all switches, the scheduler is set to strict-priority for the stacking ports, and meters are used to elevate the queue 6 priority above the priority of the other queues. This is the only scheduling method for stack ports.

Processing of Packets Received With 802.1p Priority 6

By default, 802.1p examination is turned on. Priority 7 is mapped to QoS profile QP8, and priorities 6 through 0 are mapped to QoS profile QP1. You can create other QoS profiles and can change this mapping as needed. Since you cannot create QP7 in stacking mode, 802.1p examination always maps packets with priority 6 to other CoS levels. However, you can use an ACL rule entry to set the 802.1p egress value to 6 without affecting the QoS profile assignment as shown in the example below:

```
entry VoIPinSummitStack {
  if {
    IP-TOS 46;
  } then {
    replace-dot1p-value 6;
  }
}
```

Effects on 802.1p Examination

You can turn off 802.1p examination. When stacking is enabled, the examination remains turned on for priority 6. However, the examination happens at a lower precedence than that of all other traffic groupings.

The mapping you have configured for priority 6 remains in effect, and changes accordingly if you subsequently change the mapping.

When stacking is not enabled, all 802.1p examination is disabled when the feature is turned off.

Effects on DiffServ Examination

When DiffServ examination and 802.1p examination are both turned off, the 802.1p examination for packets arriving at 802.1p priority level 6 remains on at the lowered precedence. In addition, the examination is adjusted to apply to all packets. The actual priority levels that are used for such packets are the defaults (QP1), or the values last configured using the `configure dot1p type <dot1p_priority> {qosprofile} <qosprofile>` command.

Effects on Port QoS and VLAN QoS

Port QoS and VLAN QoS have a higher precedence than the 802.1p priority examination performed when the 802.1p examination feature is turned off, and is therefore unaffected.

About Power Management and Power Over Ethernet on Stacking

The power management for Power over Ethernet (PoE) is applicable only if there are one or more Summit X440-24p, X460-XXp, X450e-XXp or X250e-XXp switches on the stack.

Each Summit X250e-XXp, X440-24p, X450e-XXp, or X460-XXp switch is equipped with its own independent power supply that provides power for the PoE ports on that switch. Power is not shared with other switches in the stack.

PoE configuration and status are maintained on the master node. Configuration information is sent by the master to the hardware on each PoE capable switch to be controlled by the local PoE hardware on that switch. Status is gathered on the master by querying the PoE hardware on each switch.

The power supply for each Summit X450e-24p or X460-24p switch is capable of providing a full 15.4 watts per PoE port for all 24 ports. The following power management CLI commands are not supported on Summit X450e-24p switches:

- `configure inline-power priority [critical | high | low] ports <port_list>`
- `configure inline-power disconnect-precedence [deny-port | lowest-priority]`

The Summit X450e-48p switches contain an optional external modular Power Supply Unit (PSU) that can provide redundant PoE power or full PoE power to all ports depending on the EPS-C/EPS600LS configuration.

When using the EPS-C/EPS600LS, the PoE capability of the Summit X450e-48p switch varies depending on the number of power modules present.

The following stacking CLI commands are applicable only to Summit X450e-48p switches:

- `configure inline-power disconnect-precedence [deny-port | lowest-priority]`
- `configure inline-power priority [critical | high | low] ports <port_list>`
- `unconfigure inline-power disconnect-precedence`
- `unconfigure inline-power priority ports [all | <port_list>]`
- `show power slot`

These commands are available in stacking mode and only function on a slot that contains Summit family switches that support PoE and PoE+.

About Stacking Node Roles, Redundancy, and Failover

ExtremeXOS supports control plane redundancy and *hitless failover*. A stack supports control plane redundancy and hitless failover. Hitless failover is supported to the extent that the failing master node and all of its ports are operationally lost, including the loss of supplied power on any PoE ports that the node provided, but all other nodes and their provided ports continue to operate. After the failover, the backup node becomes the master node.

At failover time, a new backup node is selected from the remaining standby nodes that are configured to be master capable. All operational databases are then synchronized from the new master node to the new backup node. Another hitless failover is possible only after the initial synchronization to the new backup node has completed. This can be seen using the `show switch {detail}` command on the master node and noting that the new backup node is *In Sync*.

When a backup node transitions to the master node role, it activates the Management IP interface that is common to the whole stack. If you have correctly configured an alternate management IP address, the IP address remains reachable.

When a standby node is acquired by a master node, the standby node learns the identity of its backup node. The master node synchronizes a minimal subset of its databases with the standby nodes.

When a standby node loses contact with both its acquiring master and backup nodes, it reboots.

A master node that detects the loss of an acquired standby node indicates that the *slot* the standby node occupied is now *Empty* and flushes its dynamic databases of all information previously learned about the lost standby node.

A backup node restarts if the backup node has not completed its initial synchronization with the master node before the master node is lost. When a backup node transitions to the master node role and detects that the master node has not already synchronized a minimal subset of its databases with a standby node, the standby node is restarted.

Reboot or Failure of a Non-Master Node

If a backup node fails, a standby node configured as master-capable is elected as the new backup. That new backup node is then synchronized to the databases of the master node.

For all non-master nodes, a node that reboots or is power cycled loses all of its connections to all networks for the duration of the reboot cycle. Any PoE ports that were providing power prior to the event do not supply power.

When a non-master node fails, the master node marks the related slot as *Empty*. All other nodes exclude the failed node from the control path and any customer-configured VLANs, trunk group ports, mirroring ports, and so forth.

About the Failsafe Account on SummitStack Nodes

The failsafe account is a special user account that is set up in the default configuration (see [“Failsafe Accounts” on page 56](#)). The failsafe account functions even when there is no master node in the stack. By default, the failsafe account can only be accessed through the console port of a node. The failsafe account cannot be deleted, but you can modify the user ID and password (see [“Configuring the Failsafe Account on a Stack” on page 183](#)).

Logging into a Stack

You can log into any node in a stack. However you can control more stack features when you log into the master. The following guidelines describe the options available to you when you log into different nodes:

- On master nodes, all features supported by the switch license operate correctly.
- On backup nodes, most show commands show correct data for the active stack. For example, `show vlan {virtual-router <vr-name>}` shows all configured VLANs.
- On all non-master nodes, most of the configuration commands are rejected. However, the failsafe account, enable license, and stacking configuration commands work on any node.
- On standby nodes, most show commands do not show correct data for the current stack operation. However, the `show switch {detail}`, `show licenses`, and all `show stacking` commands show correct data.
- If a node is connected to the stack and stacking is not enabled, you can still configure stacking features on that node.

The login security that is configured on the master node applies when logging into any node in the active topology. This includes any active node that is present in a slot. A node that is disabled for stacking is its own master, and uses its own security configuration.

You can log in to a SummitStack node using the following methods:

- Console connection to any node
- Management connection to the master
- Management connection to a standby node
- Telnet session over the stack from any active node to any other node in the same active topology

Logging in Through the Console Port

You can use the console port on any switch to manage the stack. If you connect to the master node, you can configure and manage the stack. If you connect to a non-master node, you can view node status and configure only a few options from the node to which you are connected. However, you can use the telnet feature to connect to another node and manage that node as if you were connected to it (see [“Logging Into a Node From Another Node” on page 154](#)).

Logging in from the Management Network

The management network is an Ethernet network to which the management port of each switch connects. The primary management IP address is assigned to the master node. You can use a terminal emulation program and this IP address to connect to the master for configuration and management.

The alternate management IP addresses allow you to connect to individual nodes from your management network. During normal operation, you connect to the stack using the primary management IP address. However, if the stack is split, you can use the alternate management IP address to connect to the other half of the stack. For more information, see [“Configuring an Alternate IP Address and Gateway” on page 180](#).

After you log in to a master or standby node through the management network, you can telnet to any other node and control that node as if you were directly connected to it. For more information, see [“Logging Into a Node From Another Node” on page 154](#).

Logging Into a Node From Another Node

You may log into any node in the active topology from any other node in the same active topology. If you do not know the slot number of the node to which you want to connect, enter the `show slot` command. You can telnet to any switch that appears in the `show slot` command display.



NOTE

If the node to which you want to connect does not appear in the `show slot {<slot> {detail} | detail }` command display, you can connect to the node through the its console port or management port.

You have the most control over the stack when you log in to the master. To determine which node is the master, use the command `show stacking`.

To telnet to another node, enter the command:

```
telnet slot <slot-number>
```

When prompted, log in normally. The switches must be active in the stack for this command to function.

The `telnet slot <slot-number>` command accepts a slot number in stacking mode. When the telnet program accepts a connection from another node in the stack, it performs security validation. The master node validates all login security information (except for the failsafe account), regardless of the node into which you are attempting to establish a login. If you are not able to log in using your user credentials, use the failsafe account to log in.

Stack Configuration Guidelines

The following sections provide guidelines for configuring a stack:

- [General Stack Configuration Guidelines on page 154](#)
- [Summit X460 Stack Configuration Guidelines on page 155](#)
- [Summit X480 Stack Configuration Guidelines on page 156](#)
- [Summit X650 Stack Configuration Guidelines on page 157](#)
- [Summit X670 Stack Configuration Guidelines on page 157](#)

General Stack Configuration Guidelines

Before deploying a new stack, consider the following guidelines:

- Plan to use the stack as if it were a single multi-slot switch. You need to decide the number and type of stackable switches in the stack and how the stack ports will be connected to the network.
- Physically locate the intended master and backup nodes adjacent to each other, and plan to directly connect these nodes to each other so that ExtremeXOS application synchronization traffic is localized to a single stack link.
- Use stacking cables to interconnect the stack nodes into a ring topology (see “[SummitStack Topologies](#)” on page 143). Only include the nodes that are intended to be active in the stack. To see the recommended procedures for installing and interconnecting a stack, refer to the *Summit Family Switches Hardware Installation Guide*.

- You can physically connect the stack to your networks before the nodes are configured. However, the default configuration on a non-stacking mode switch assumes a default untagged VLAN that contains all switch ports. When first powered on, the switch acts as a Layer 2 switch, possibly resulting in network loops.
- Make sure all nodes support the SummitStack feature (see [Appendix A, “Feature License Requirements”](#)) and are running the same ExtremeXOS software version. To view the ExtremeXOS software version on a node, restart the node and run the command `show version {detail | process <name> | images {partition <partition>} {slot <slotid> }`. If any of the nodes do not have the right version, install the correct version on that switch. Extreme Networks recommends that you use the same image partition on all nodes. Once stacking is enabled, image upgrade from the stack is possible only if the same image is selected on all nodes.
- If you intend to deploy new units that might be part of a stack in the future, you might want to turn on stacking mode during initial deployment to avoid a future restart. The only disadvantages of stacking mode are the loss of QoS profile QP7 and the reservation of some of the packet buffer space for stacking control traffic.
- You can configure the stack by logging into the master or any of the other nodes. For more information, see [“Logging into a Stack” on page 153](#).
- If the master-capable stackable switches have different purchased license levels, you might need to configure license level restrictions on some nodes before those nodes can join the stack (see [“Managing Licenses on a Stack” on page 184](#)).
- If the stack supports any feature pack license (such as MPLS or Direct Attach), that feature pack license must be installed on all master capable nodes to support that feature and prevent traffic interruption if a failover event occurs.
- Most stacking specific configurations are effective only after a restart (see [Table 22](#)). However, most non-stacking configuration commands take effect immediately and require no restart.
- A basic stack configuration can be achieved by using the procedure described in [“About Easy Setup” on page 158](#).

**NOTE**

If EAPS, Spanning Tree, or any Layer 2 redundancy protocol is not running on the network, you need to make sure that your network connections do not form a network loop.

Summit X460 Stack Configuration Guidelines

Before deploying a new stack with Summit X460 switches, consider the following guidelines:

- In a stack that contains Summit X460 switches and other Summit switch models, a Summit X460 switch might provide more memory and more features than other Summit switch models, and this affects master node selection, backup node selection, and failover operation. Before configuring a stack with Summit X460 switches and other Summit switch models, review [“Configuring the Master, Backup, and Standby Roles” on page 175](#)
- To use the failover feature in the stack, a second Summit X460 is required, and it must be the backup node.
- Beginning with ExtremeXOS Release 12.5.1, only the master and master capable nodes require a license to support special features such as MPLS.

- If the MPLS feature pack is installed on the master capable nodes, the following guidelines apply:
 - Each stack switch must meet the software and hardware requirements listed in [Table 142 of Appendix A, “Feature License Requirements.”](#)
 - You must configure the enhanced stacking protocol on each Summit family switch.
 - Although you can mix Summit X460, X480, and X670 switches in a stack, Extreme Networks recommends that you do not mix these switch types if the desired routing table exceeds the supported limit for the Summit X460 switch, which is 12,256 IPv4 LPM routes.
- Summit X460 switches support multiple types of stacking cables for connection between Summit X460 compatible SummitStack option cards and other Summit switches. For information on which cables to use with each type of Summit family switch, see the *Summit Family Switches Hardware Installation Guide*.
- When a SummitStack option card is installed in a Summit X460 switch, the switch prompt remains unchanged.

**NOTE**

When MPLS is enabled on a stack, you can only add a MPLS-compatible Summit family switches to the stack.

Summit X480 Stack Configuration Guidelines

Before deploying a new stack with Summit X480 switches, consider the following guidelines:

- In a stack that contains Summit X480 switches and other Summit switch models, a Summit X480 switch might provide more memory and more features than other Summit switch models, and this affects master node selection, backup node selection, and failover operation. Before configuring a stack with Summit X480 switches and other Summit switch models, review [“Configuring the Master, Backup, and Standby Roles” on page 175](#)
- To use the failover feature in the stack, a second Summit X480 is required, and it must be the backup node.
- Beginning with ExtremeXOS Release 12.5.1, only the master and master capable nodes require a license to support special features such as MPLS.
- If the MPLS feature pack is installed on the master capable nodes, the following guidelines apply:
 - Each stack switch must meet the software and hardware requirements listed in [Table 142 of Appendix A, “Feature License Requirements.”](#)
 - You must configure the enhanced stacking protocol on each Summit family switch.
 - Although you can mix Summit X460, X480, and X670 switches in a stack, Extreme Networks recommends that you do not mix these switch types if the desired routing table exceeds the supported limit for the Summit X460 switch, which is 12,256 IPv4 LPM routes.
- Summit X480 switches support multiple types of stacking cables for connection between Summit X480 compatible SummitStack option cards and other Summit switches. For information on which cables to use with each type of Summit family switch, see the *Summit Family Switches Hardware Installation Guide*.
- The switch prompt reflects the installed VIM in parenthesis as shown in the following examples:
 - Summit X480-48t switch with no VIM installed: X480-48t.
 - Summit X480-48t switch with VIM2-SummitStack installed: X480-48t(SS).
 - Summit X480-48t switch with VIM2-SummitStack-V80 installed: X480-48t(SSV80).

- Summit X480-48t switch with VIM2-SummitStack128 installed: X480-48t(SS128).
- Summit X480-48t switch with VIM2-10G4X installed: X480-48t(10G4X).

Summit X650 Stack Configuration Guidelines

Before deploying a new stack with Summit X650 switches and no Summit X480 switches, consider the following guidelines:

- In a stack that contains Summit X650 switches and other Summit switch models, a Summit X650 switch might provide more memory and more features than other Summit switch models, and this affects master node selection, backup node selection, and failover operation. Before configuring a stack with Summit X650 switches and other Summit switch models, review [“Configuring the Master, Backup, and Standby Roles” on page 175](#)
- Summit X650 switches support multiple types of stacking cables for connection between Summit X650 compatible SummitStack option cards and other Summit switches. For information on which cables to use with each type of Summit family switch, see the *Summit Family Switches Hardware Installation Guide*.
- Connection between a Summit X650 switch with an installed VIM1-SummitStack256 option card and a Summit X650 switch with an installed VIM1-SummitStack512 option card is not supported.
- When the VIM1-SummitStack512 option is installed in a Summit X650 switch, the Summit X650 switch can connect to only one other Summit X650 switch with an installed VIM1-SummitStack512. If you remove a cable between the two VIM1-SummitStack512 option cards, the stack fails. The cabling is unique to this back-to-back configuration and is described in the *Summit Family Switches Hardware Installation Guide*.



NOTE

For information on upgrading Summit X650 switches to use the VIM1-SummitStack512 option card, see [“Upgrading a Summit X650 with a VIM1-SummitStack512” on page 204](#).

Summit X670 Stack Configuration Guidelines

Before deploying a new stack with Summit X670 switches, consider the following guidelines:

- In a stack that contains Summit X670 switches and other Summit switch models, a Summit X670 switch might provide more memory and more features than other Summit switch models, and this affects master node selection, backup node selection, and failover operation. Before configuring a stack with Summit X670 switches and other Summit switch models, review [“Configuring the Master, Backup, and Standby Roles” on page 175](#)
- To use the failover feature in the stack, a second Summit X670 is required, and it must be the backup node.
- Only the master and master capable nodes require a license to support special features such as MPLS.
- If the MPLS feature pack is installed on the master capable nodes, the following guidelines apply:
 - Each stack switch must meet the software and hardware requirements listed in [Table 142 of Appendix A, “Feature License Requirements.”](#)
 - You must configure the enhanced stacking protocol on each Summit family switch.

- Although you can mix Summit X460, X480, and X670 switches in a stack, Extreme Networks recommends that you do not mix these switch types if the desired routing table exceeds the supported limit for the Summit X460 switch, which is 12,256 IPv4 LPM routes.
- Summit X670V switches support multiple types of stacking cables for connection between the VIM4-40G4X option card and other Summit switches. For information on which cables to use with each type of Summit family switch, see the *Summit Family Switches Hardware Installation Guide*.

**NOTE**

For information on upgrading Summit X670 switches to use the VIM4-40G4x option card, see [“Upgrading a Summit X670V Switch with a VIM4-40G4x Option Card” on page 207](#).

Configuring a New Stack

The following sections provide information on configuring a new stack:

- [About Easy Setup on page 158](#)
- [Configuration Procedure on page 159](#)
- [Example: Deploying a New Stack on page 160](#)

About Easy Setup

Using easy setup, you can configure a stack without entering many of the stacking CLI commands. The easy setup procedure creates a stack with a master and a backup. The remaining nodes are configured with the master capability disabled. Easy Setup provides you an easy way to configure the required stacking parameters for all nodes.

To avoid an additional stack reboot, Extreme Networks recommends that you configure the following stack related features before invoking easy setup:

- Stacking license restriction (see [“Managing Licenses on a Stack” on page 184](#)).
- SummitStack-V (see [“Using Ethernet Ports for Stacking \(SummitStack-V\)” on page 167](#)).
- VIM3-40G4X port configuration (see [“Configuring Stacking Port Operation with the VIM3-40G4X Option Card” on page 170](#)).
- VIM4-40G4X port configuration (see [“Configuring Stacking Port Operation with the VIM4-40G4X Option Card” on page 170](#)).
- Enhanced protocol for MPLS support on a stack (see [“Selecting the Stacking Protocol” on page 171](#)).

The configuration procedure described in the next section starts easy setup. You can also start easy setup by entering the `configure stacking easy-setup` command.

Easy setup performs the functions of the following commands required to configure and activate a ring topology stack:

```
enable stacking
configure stacking slot-number automatic
configure stacking mac-address
configure stacking redundancy minimal
configure stacking protocol
reboot stack-topology
```

In a daisy chain topology (which is not recommended), easy setup designates the node at the beginning of the chain as the master, and executes the above commands with the following command change:

```
configure stacking redundancy none.
```

Configuration Procedure

To configure a new stack:

- 1 Physically connect the nodes using the stacking ports. Instructions for setting up the stacking hardware are provided in the *Summit Family Switches Hardware Installation Guide*.



NOTE

To complete the cabling, you must install any option cards you plan to use.

- 2 Power on the nodes.
- 3 If you are using a Summit X650V switch with the VIM3-40G4X option card, configure the stacking port speed and partition as described in [“Configuring Stacking Port Operation with the VIM3-40G4X Option Card” on page 170](#).
- 4 If you are using a Summit X670V switch with the VIM4-40G4X option card, configure the stacking port speed and partition as described in [“Configuring Stacking Port Operation with the VIM4-40G4X Option Card” on page 170](#).
- 5 If needed, enable the switch stacking ports as described in [“Enabling and Disabling Stacking Support for Summit X650 and X670 Switches” on page 166](#).
- 6 If the stack will use the SummitStack-V feature, configure those switches that will use alternate stack ports as described in [“Using Ethernet Ports for Stacking \(SummitStack-V\)” on page 167](#).
- 7 If the stack will use MPLS, the stack must contain only Summit X460, X480, and X670 switches, and you must configure those switches to use the enhanced stacking protocol as described in [“Selecting the Stacking Protocol” on page 171](#).
- 8 Log in to any of the nodes through the console port, preferably the one you want to use as the master. If you plan to use Easy Setup, log into the intended master node.
If the stack is a new stack, the default parameters are in effect.
- 9 Run the `show stacking` command to verify the stack. The show stacking command should display all nodes in the stack. All nodes are in a disabled state and all nodes appear as master nodes.
- 10 If necessary, configure a license level restriction (see [“Managing Licenses on a Stack” on page 184](#)).
- 11 Enable stacking on all nodes. To enable stacking on all nodes, run the command `enable stacking` from the master. This command presents you the option of using the Easy Setup procedure, which is described in [“About Easy Setup” on page 158](#). If you choose this option, skip steps 10-12.
- 12 Assign slot numbers to all nodes (see [“Configuring Slot Numbers” on page 175](#)).
- 13 Assign a MAC address to the stack (see [“Assigning a MAC Address for the Stack” on page 177](#)).
- 14 (Optional) Configure node priorities on each slot (see [“Configuring the Master, Backup, and Standby Roles” on page 175](#)).
- 15 (Optional) Disable the master capability on selected nodes (see [“Configuring Master-Capability” on page 179](#)).
- 16 Restart the stack using the command `reboot stack-topology`.
The configuration is set to default values while entering the stacking mode, so all previously entered configuration information (except for the NVRAM-based stacking parameters, selected image, and failsafe account information) is not available.

- 17 Log in to the intended master node and verify the stack using `show stacking`, `show slot`, and `show stacking configuration` commands. If the stack configuration is successful:
 - All nodes are visible in the stack.
 - All nodes move to the active state.
 - Some time after the nodes become active, each node is present in the configured slot.
 - After the roles are finalized, you can see one master node, one backup, and a set of standby nodes.
- 18 Verify that the master node is the one you intended to be the master.
- 19 (Optional) Configure an alternate management IP address on each node (see [“Configuring an Alternate IP Address and Gateway”](#) on page 180).
- 20 Configure a management IP network.
- 21 Configure other normal parameters such as VLANs, IP subnetworks, trunk groups, and so forth.
- 22 Save the configuration (see [“Saving the Configuration”](#) on page 183).

Example: Deploying a New Stack

This section provides an example of deploying a new stack with 8 nodes, which are numbered Node 1 through Node 8. Node 1 is assigned to slot 1 and becomes the master. Node 2 is assigned to slot 2 and becomes the backup node. Node 3 to Node 8 are assigned slots 3 to 8, respectively, and become standby nodes.

Before you begin the configuration, log in to the nodes and get the following information if you do not already have it:

- The software release installed on the node (`show version {detail | process <name> | images {partition <partition> } {slot <slotid> } }` command)
- The image selected (all nodes need to be operating from the same selected image). By default, new nodes have the primary image selected.
- The purchased license information (`show licenses` command)

Also, while logged into each node, if you plan to use the SummitStack-V feature, configure the required alternate ports on that node or enable stacking-support as required (see [“Using Ethernet Ports for Stacking \(SummitStack-V\)”](#) on page 167).

For this example, assume that all nodes except node 8 have a purchased Advanced Edge license level, and that node 8 has a purchased license level of Edge.

To deploy the stack:

- 1 Power up all nodes, if you have not already done so.
- 2 Log in to Node 1. The `safe-default-script` may be displayed at this time. If so, for now, accept the default answer to each question.

3 Run the show stacking command.

```
* X450a-24x.1 # show stacking
Stack Topology is a Ring
This node is not in an Active Topology
Node MAC Address      Slot  Stack State  Role      Flags
-----
*00:04:96:26:6c:df   -     Disabled    Master    ---
00:04:96:26:6c:e3   -     Disabled    Master    ---
00:04:96:26:6b:e4   -     Disabled    Master    ---
00:04:96:26:6b:f7   -     Disabled    Master    ---
00:04:96:26:6b:ed   -     Disabled    Master    ---
00:04:96:26:6b:ec   -     Disabled    Master    ---
00:04:96:26:6d:1f   -     Disabled    Master    ---
00:04:96:26:6a:e9   -     Disabled    Master    ---
* - Indicates this node
Flags: (C) Candidate for this active topology, (A) Active Node
       (O) node may be in Other active topology
* X450a-24x.2 #
```

The stack topology is a ring and all the nodes are present in the stack. Node 1 is at the top and Node 8 at the bottom. The asterisk (*) before a node in the above display, indicates the node to which you have logged in.

4 Display a summary of the configurations of all nodes in the stack using the command show stacking configuration:

```
* X450a-24x.2 # show stacking configuration
Stack MAC in use: <none>
Node          Slot      Alternate      Alternate
MAC Address   Cfg Cur Prio Mgmt IP / Mask  Gateway      Flags      Lic
-----
*00:04:96:26:6c:df 1  -   Auto <none>      <none>      -c----- --
00:04:96:26:6c:e3 1  -   Auto <none>      <none>      -c----- --
00:04:96:26:6b:e4 1  -   Auto <none>      <none>      -c----- --
00:04:96:26:6b:f7 1  -   Auto <none>      <none>      -c----- --
00:04:96:26:6b:ed 1  -   Auto <none>      <none>      -c----- --
00:04:96:26:6b:ec 1  -   Auto <none>      <none>      -c----- --
00:04:96:26:6d:1f 1  -   Auto <none>      <none>      -c----- --
00:04:96:26:6a:e9 1  -   Auto <none>      <none>      -c----- --

* - Indicates this node
Flags: (C) master-Capable in use, (c) master-capable is configured,
       (E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
       (M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
       (N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced
       configured,
       (i) Stack MACs configured and in use are not the same or unknown,
       (-) Not in use or not configured
License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
       (c) Core, (a) Advanced edge, or (e) Edge configured,
       (-) Not in use or not configured
```

Since this example uses new nodes, the factory defaults are displayed.

5 Configure a license restriction of Edge so that node 8 can come up in the stack.

```
* X450a-24x.7 # configure stacking license-level edge
```

This command will take effect at the next reboot of the specified node(s).

Note that it is preferable to upgrade the license of node 8 instead of restricting the license level of the entire stack as is shown here.

6 From the master, use the Easy Setup option to enable stacking on all nodes.

```
* X450a-24x.3 # enable stacking
```

You have not yet configured all required stacking parameters.

Would you like to perform an easy setup for stacking operation? (y/N) Yes

Executing "configure stacking easy-setup" command...

For every node in the 8-node stack, this command will:

- enable stacking
- configure a stack MAC address
- choose and configure a slot number (this node will be assigned to slot 1)
- configure redundancy to minimal (slot 1 will be the master node)

Upon completion, the stack will automatically be rebooted into the new configuration.

Warning: If stacking is already configured, this command will alter that configuration.

Do you wish to proceed? (y/N) Yes

Stacking configuration is complete. Rebooting...

After a time the following message appears:

Authentication Service (AAA) on the master node is now available for login.

7 Log in to Node 1. At this time, the normal login security information is set to the defaults, so use the default admin account with no password to log in.

The safe-default-script starts.

Select the values for normal operation. You may configure the failsafe account now. The failsafe account user id, password, and other related values are saved in non-volatile storage in all active nodes.

8 Run the show stacking and show stacking configuration commands to verify the configuration.

```
* Slot-1 Stack.1 # show stacking
```

Stack Topology is a Ring

Active Topology is a Ring

Node	MAC Address	Slot	Stack State	Role	Flags
*00:04:96:26:6c:df		1	Active	Master	CA-
00:04:96:26:6c:e3		2	Active	Backup	CA-
00:04:96:26:6b:e4		3	Active	Standby	CA-
00:04:96:26:6b:f7		4	Active	Standby	CA-
00:04:96:26:6b:ed		5	Active	Standby	CA-
00:04:96:26:6b:ec		6	Active	Standby	CA-
00:04:96:26:6d:1f		7	Active	Standby	CA-
00:04:96:26:6a:e9		8	Active	Standby	CA-

* - Indicates this node

Flags: (C) Candidate for this active topology, (A) Active Node

(O) node may be in Other active topology

```
* Slot-1 Stack.2 # show stacking configuration
Stack MAC in use: 00:04:96:26:6c:df
Node          Slot          Alternate          Alternate
MAC Address   Cfg Cur Prio Mgmt IP / Mask Gateway          Flags          Lic
-----
*00:04:96:26:6c:df 1    1    Auto <none>          <none>          CcEeMm--- Ee
00:04:96:26:6c:e3 2    2    Auto <none>          <none>          CcEeMm--- Ee
00:04:96:26:6b:e4 3    3    Auto <none>          <none>          --EeMm--- Ee
00:04:96:26:6b:f7 4    4    Auto <none>          <none>          --EeMm--- Ee
00:04:96:26:6b:ed 5    5    Auto <none>          <none>          --EeMm--- Ee
00:04:96:26:6b:ec 6    6    Auto <none>          <none>          --EeMm--- Ee
00:04:96:26:6d:1f 7    7    Auto <none>          <none>          --EeMm--- Ee
00:04:96:26:6a:e9 8    8    Auto <none>          <none>          --EeMm--- Ee
```

* - Indicates this node

Flags: (C) master-Capable in use, (c) master-capable is configured,
(E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
(M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
(N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced
configured,
(i) Stack MACs configured and in use are not the same or unknown,
(-) Not in use or not configured

License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
(c) Core, (a) Advanced edge, or (e) Edge configured,
(-) Not in use or not configured

The user prompt contains the slot number on which the console session is running. Also notice that the platform has changed from X450a-24x to Stack. The nodes in the stack have become Active and have been assigned node roles. The configured slot numbers have become current, and the other stacking parameters have also taken effect.

9 To see the ExtremeXOS state of each node, run the command `show slot` on the master:

```
* Slot-1 Stack.3 # show slot
Slots      Type          Configured          State          Ports
-----
Slot-1     X450a-24x          Operational          26
Slot-2     X450a-24xdc        Operational          26
Slot-3     X450a-24tdc        Operational          26
Slot-4     X450a-24tdc        Operational          26
Slot-5     X450a-24tdc        Operational          26
Slot-6     X450a-24tdc        Operational          26
Slot-7     X450a-24xdc        Operational          26
Slot-8     X450e-48p          Operational          50
```

```
* Slot-1 Stack.4 #
```

10 Configure a block of IP addresses and a gateway for the alternate management IP functionality.

```
* X450a-24x.8 # config stacking alternate-ip-address 10.66.13.200/24 10.66.13.1
automatic
```

Choose the block as a subset of addresses in the intended primary management subnet that will be configured later. Arrange the stack so that the alternate IP addresses assigned to each node are easily calculated so you can easily find the address to use when you need to log into a severed stack segment.

There are two methods you can follow:

- Choose the stack IP address, and then allocate a consecutive block of addresses that immediately follow the stack IP address. For example, if the Mgmt VLAN is configured with the address 10.4.73.8, and if there are three master-capable nodes in the stack, then their alternate IP addresses could be 10.4.73.9, 10.4.73.10, and 10.4.73.11.
- Use the configured Mgmt VLAN address and the slot number to form the alternate IP address. For example, if 10.4.73.10 is the Mgmt VLAN address, and you are configuring the alternate IP address for slot 1, the alternate IP address could be 10.4.73.11; and for slot 8 it could be 10.4.73.18.

11 Configure the management IP address, subnet, and gateway (VLAN Mgmt). You can configure non-stacking parameters such as security information, VLANs, load aggregation, spanning tree, and routing protocols now.

12 Save the configuration.

Converting a Standalone Node Deployment to a Stack

This section explains how to add a node to a currently deployed standalone (non-stacking) node for adding ports and centralizing management.

Node 1 is the currently deployed node, and Node 2 is the new node to be used to form a stack of two nodes.

Before you begin:

- Verify that the ExtremeXOS version running on both stackable switches is version 12.0 or later. Both the nodes must be running the same ExtremeXOS release.
- Use the `show licenses` command to verify that the purchased license levels of the switches that you intend to be master-capable (as potential master or backup nodes) meet your requirements (see [“Managing Licenses on a Stack” on page 184](#)).
- (Only for nodes on which you have not yet configured the SummitStack feature) If you want to preserve the ExtremeXOS configuration in use on Node 1, use the `upload configuration [<hostname> | <ipaddress>] <filename> {vr <vr-name>}` command to retrieve the configuration in the CLI command format. The file may be used to restore the ExtremeXOS configuration to the stack after the stacking configuration is complete.

To convert a standalone node to a stack:

- 1** Connect the stacking ports of the two nodes together to form a ring topology. You can power on Node 2 before, during, or after the connection.
- 2** If needed, enable the switch stacking ports as described in [“Enabling and Disabling Stacking Support for Summit X650 and X670 Switches” on page 166](#).
- 3** If the stack will use the SummitStack-V feature, configure those switches that will use alternate stack ports as described in [“Using Ethernet Ports for Stacking \(SummitStack-V\)” on page 167](#).
- 4** If the stack will use MPLS, the stack must contain only Summit X460, X480, and X670 switches, and you must configure those switches to use the enhanced stacking protocol as described in [“Selecting the Stacking Protocol” on page 171](#).
- 5** Log into Node 1 (which becomes the master node and slot 1 in the stack).
- 6** If necessary, configure the stacking license level restriction (see [“Restricting a Switch License Level” on page 186](#)).

- 7 (Optional) Configure the master node priority (see [“Configuring the Master, Backup, and Standby Roles” on page 175](#)).
- 8 Enable stacking on both nodes by using the command `enable stacking`. The choice to run Easy Setup is offered. If you choose Easy Setup, skip steps 6-9 below.
- 9 Assign slot numbers to the nodes (see [“Configuring Slot Numbers” on page 175](#)).
 - You can specify a number for each node manually.
Or
 - You can use the automatic slot number assignment.
- 10 Assign a MAC address to the stack (see [“Assigning a MAC Address for the Stack” on page 177](#)).
- 11 (Optional) Configure stacking redundancy or master-capability as desired (see [“Configuring Master-Capability” on page 179](#)).
- 12 Restart the stack using the command `reboot stack-topology`.
- 13 After the stack reboots, log in to the console port of the master node. At this time, by default, the user ID is `admin` and there is no password.
- 14 Configure the desired safe-default-script parameters when prompted. The failsafe account parameter configuration is pushed to the nonvolatile memories of both nodes.
- 15 Use the `show stacking` and `show stacking configuration` commands to confirm that the stack is now configured and operating as expected.
- 16 (Optional) Configure an alternate management IP address on each node (see [“Configuring an Alternate IP Address and Gateway” on page 180](#)).

To restore the ExtremeXOS configuration, you must first edit the file created during configuration upload. All port numbers in the file are simple numeric values. You must replace the port number with `slot:port` format with slot number set to one (1). Once the file is ready, you can:

- Make sure the file has the extension `.xsf` (rename if necessary).
- Use TFTP to get the file onto the master node.
- Use the `load script <filename> {arg1} {arg2} ... {arg9}` command to run the commands in the file.
- Use the `save configuration {primary | secondary | <existing-config> | <new-config>}` command.

If you intend to deploy new units that are not to be stacked, consider whether or not you want to eventually use them in a stack before you deploy them. If so, you should turn on stacking mode during initial deployment. If a new node is subsequently added, there is no need to switch the existing node to stacking mode, and since the existing stacking configuration uses the `slot:port` numbering format, there is no need to edit the configuration file. The only disadvantages of deployment in stacking mode are the inability to use QoS profile QP7 for your traffic and the reservation of some of the packet buffer space for stacking control traffic.

Stack Configuration Tasks

This section describes how to perform the following configuration tasks:

- [Enabling and Disabling Stacking Support for Summit X650 and X670 Switches on page 166](#)
- [Using Ethernet Ports for Stacking \(SummitStack-V\) on page 167](#)
- [Configuring Stacking Port Operation with the VIM4-40G4X Option Card on page 170](#)
- [Selecting the Stacking Protocol on page 171](#)
- [Enabling the Stack on page 171](#)
- [Verifying the Configuration on page 172](#)
- [Setting the Command Prompt on page 174](#)
- [Configuring Slot Numbers on page 175](#)
- [Configuring the Master, Backup, and Standby Roles on page 175](#)
- [Assigning a MAC Address for the Stack on page 177](#)
- [Configuring Master-Capability on page 179](#)
- [Configuring an Alternate IP Address and Gateway on page 180](#)
- [Configuring the Failsafe Account on a Stack on page 183](#)
- [Disabling Stacking on page 183](#)
- [Saving the Configuration on page 183](#)

Enabling and Disabling Stacking Support for Summit X650 and X670 Switches

Summit X650 and X670 series switches provide *dual-purpose* hardware, which can be configured to support any one of the following configurations:

- Data communications on physical data ports 23 and 24.
- Stacking communications on VIM1-SummitStack Versatile Interface Module (VIM) native stack ports 1 and 2.
- Stacking communications on physical data ports 23 and 24.

On Summit X650 switches, data communications are enabled on ports 23 and 24 by default. If you want to add a Summit X650 switch to a stack, you must enable stacking protocol communications by entering the following command:

```
enable stacking-support
```

When the stacking-support option is enabled, data communications stops on ports 23 and 24. If the VIM1-SummitStack option card is present, the stacking-support option is enabled on native stack ports 1 and 2. If no VIM1-SummitStack option card is installed, the stacking-support option is enabled on ports 23 and 24.



NOTE

When you enable the stacking-support option, you are configuring the switch to support the stacking protocol. To enable stacking protocol operation, you must enter the `enable stacking` command. For more information on stacking communications on physical data ports, see [“Using Ethernet Ports for Stacking \(SummitStack-V\)” on page 167](#).

To configure the switch data ports to use the Ethernet protocol instead of the stacking protocol, use the following command:

```
disable stacking-support
```

Using Ethernet Ports for Stacking (SummitStack-V)

The SummitStack-V feature allows you to use Ethernet ports that run at at least 10 Gbps as stacking ports. This feature allows you to overcome the length limit on the custom stacking cables used with dedicated or *native* stack ports. For example, Summit family switches on different floors in a building or in different buildings on a campus can be connected to form a stack using standard Ethernet cables.

The SummitStack-V feature also allows you to stack switches that have no native stacking ports but do have at least two Ethernet ports, which can be configured to support either data communications or the stacking protocol. When these dual-purpose ports are configured to support stacking, they are called *alternate* stack ports to distinguish them from the *native* stack ports that use custom cables.

Alternate stack ports use the ExtremeXOS proprietary stacking protocol, not the standard Ethernet protocol. This means that the alternate stack ports between two stack switches must be directly connected, with no intervening switch connections.

Summit family switches that support alternate stack ports have two logical stack ports: Stack Port 1 and Stack Port 2. Each logical stack port is mapped to one physical data port that operates as an alternate stack port when the stacking protocol is enabled with the *stacking-support option*.

When the stacking-support option is enabled, data communications stops on the physical data ports listed in [Table 23](#). When stacking is enabled (with the `enable stacking` command), the stacking protocol for logical stack ports 1 and 2 operates on the physical data ports listed in [Table 23](#).

Table 23: Summit Family Switch Support for Alternate Stack Ports

Summit Switch Model Number	Summit Switch Option Card	Alternate Port for Stack Port 1	Alternate Port for Stack Port 2	Stacking-Support Option Control ^a	Stacking Port Selection Control ^b
X450a-24t X450a-24tDC X450a-24x X450a-24xDC X450e-24p	XGM2-2xf XGM2-2xn XGM2-2sf XGM2-2bt ^c None	25 ^d	26 ^c	No	Yes
X450a-48t X450a-48tDC X450e-48p	XGM2-2xf XGM2-2xn XGM2-2sf XGM2-2bt ^b None	49 ^c	50 ^c	No	Yes

Table 23: Summit Family Switch Support for Alternate Stack Ports (Continued)

Summit Switch Model Number	Summit Switch Option Card	Alternate Port for Stack Port 1	Alternate Port for Stack Port 2	Stacking-Support Option Control ^a	Stacking Port Selection Control ^b
X460-48t X460-48p	XGM3-2sf with either the XGM3 SummitStack V80 or XGM3 SummitStack module or neither	S1 ^c	S2 ^c	No	Yes
X460-24t X460-24x X460-24p		S1 ^c	S2 ^c	No	Yes
X460-48x E4G-400		S1 ^c	S2 ^c	No	Yes
X480-48t X480-48x	VIM2-10G4X	S3	S4	Yes	No
	VIM2-SummitStack	N/A	N/A	N/A	N/A
	VIM2-SummitStack-V80	N/A	N/A	N/A	N/A
	VIM2-SummitStack128	N/A	N/A	N/A	N/A
	None	N/A	N/A	N/A	N/A
X480-24x	VIM2-10G4X	S3	S4	Yes	No
	VIM2-SummitStack	25	26	No	Yes
	VIM2-SummitStack-V80	25	26	No	Yes
	VIM2-SummitStack128	25	26	No	Yes
	None	25	26	Yes	No
X650-24x	VIM1-10G8X	31	32	No	Yes
	VIM3-40G4X	23	24	Yes	Yes
	VIM1-SummitStack	24	23	Yes	Yes
	VIM1-SummitStack256	24	23	No	Yes
	VIM1-SummitStack512	N/A	N/A	N/A	N/A
X650-24t ^e	VIM1-10G8X	31	32	No	Yes
	VIM3-40G4X	23	24	Yes	Yes
	VIM1-SummitStack	23	24	Yes	Yes
	VIM1-SummitStack256	23	24	No	Yes
	VIM1-SummitStack512	N/A	N/A	N/A	N/A
X670-48x	None	47	48	Yes	Yes
X670V-48x	VIM4-40G4X	47	48	Yes	Yes

- To operate in a stack, the `enable stacking-support` must be entered for switch configurations for which this column displays Yes.
- The `configure stacking-support stack-ports` command is supported only on Summit switch configurations for which this column displays Yes.
- SummitStack-V requires XGM2-2bt version 4 or later option cards.
- This alternate port number requires an installed option card. You can configure the port without the option card, but the configuration does not apply until the switch restarts with the required option card.
- SummitStack-V requires Summit X650-24t switch version 2 or later.

The following sections describe how to manage the SummitStack-V feature:

- [Enabling and Disabling the Stacking-Support Option on page 169](#)
- [Selecting Native and Alternate Stack Ports on page 169](#)

Enabling and Disabling the Stacking-Support Option

The stacking-support option is automatically enabled for many Summit switch and option card configurations. However, some Summit switch and option card configurations require you to enable the stacking-support option before a switch can participate in a stack. [Table 23](#) indicates which switch and option cards require you to enable the stacking-support option. If the *Stacking-Support Option Control* column in this table displays *Yes*, the stacking-support option must be enabled before the switch can join a stack.

To enable the stacking-support option, enter the following command:

```
enable stacking-support
```

To configure the switch data ports to use the Ethernet protocol instead of the stacking protocol, use the following command:

```
disable stacking-support
```

Selecting Native and Alternate Stack Ports

On switches that provide both native stack ports and alternate stack ports, you can configure each logical stack port to use either the native stack port or the alternate stack port. You can configure logical stack ports to use any of the following physical stack port configurations:

- Two native stack ports
- Two alternate stack ports
- One native stack port and one alternate stack port

For the newer switches with the VIM3-40G4X and VIM4-4, when an alternate stack port is selected, the corresponding native stack port is automatically disabled and cannot be used.

When the *Stacking Port Selection Control* column in [Table 23](#) displays *Yes* for a switch configuration, you can choose between native and alternate ports. The default selection is the native stack ports. To select between the native and alternate stack ports, use the following command:

```
configure stacking-support stack-port [<stack-ports> | all] selection [native {V80 | V160} | V320} | alternate]
```

To display the SummitStack-V configuration, use the following commands:

```
show stacking-support
show stacking stack-ports
show stacking {node-address <node-address> | slot <slot-number>} detail
```

To unconfigure the SummitStack-V feature, use the following command:

```
unconfigure stacking-support
```



NOTE

Commands that contain the `stacking-support` keyword apply to the local switch only. This means that each switch that is to use alternate stacking ports must be separately configured. When the stack is fully active, you can use the `telnet slot <slot-number>` command to log in to another node over the stack to unconfigure SummitStack-V on that node only. There is no way to intentionally or accidentally unconfigure the stacking-support options on all nodes in a stack.

Once the SummitStack-V feature has been configured as required on all nodes in a stack, reboot each node. Then you can use the `show stacking stack-ports` command to verify that the stack has been properly connected. Subsequently you can use the stacking commands described in the following sections to complete the stacking configuration.

Configuring Stacking Port Operation with the VIM3-40G4X Option Card

When the VIM3-40G4X option card is installed, you can use the following ports for stacking:

- The native stacking ports on the VIM3-40G4X option card, which can be configured for an 80 Gbps, 160 Gbps, or 320 Gbps data rate. These ports can also be partitioned to operate as one 40 Gbps data port or four 10 Gbps data ports.
- The alternate stacking ports, which are defined in [Table 23](#).

To select between the native and alternate stack ports, use the following command:

```
configure stacking-support stack-port [<stack-ports> | all] selection [native {V80 | V160} | V320} | alternate]
```

To configure the port partition, use the following command:

```
configure ports [<port_list> | all] partition [4x10G | 1x40G]
```



NOTE

After a configuration change, you must restart the switch to use the stacking ports.

Configuring Stacking Port Operation with the VIM4-40G4X Option Card

When the VIM4-40G4X option card is installed, you can use the following ports for stacking:

- The native stacking ports on the VIM4-40G4X option card, which can be configured for an 80 Gbps, 160 Gbps, or 320 Gbps data rate. These ports can also be partitioned to operate as one 40 Gbps data port or four 10 Gbps data ports.
- The alternate stacking ports, which are defined in [Table 23](#).

To select between the native and alternate stack ports, use the following command:

```
configure stacking-support stack-port [<stack-ports> | all] selection [native {V80 | V160} | V320} | alternate]
```

To configure the port partition, use the following command:

```
configure ports [<port_list> | all] partition [4x10G | 1x40G]
```



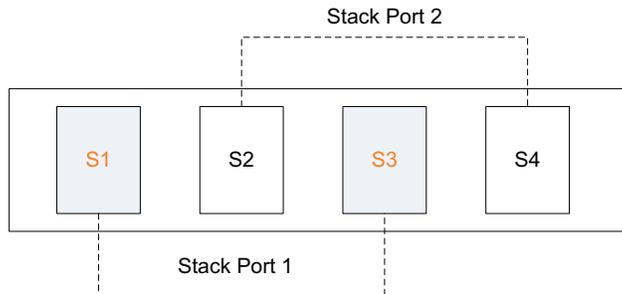
NOTE

After a configuration change, you must restart the switch to use the stacking ports.

The stacking rate of 320Gbps can be used across a stack of X670 (equipped with VIM4-40G4X), X650 or X480 (equipped with VIM3-40G4X) and future Summits using the QSFP+ connection and cables. This solution uses two trunked HiGig ports at 40G each for 80 Gbps per stack port. Four 40G HiGig ports are used on the Trident switch chip for this solution.

320G Stack port 1 is formed by trunking VIM4 ports S1 & S3. Similarly 320G stack port 2 is formed by trunking VIM4 port S2 & S4. The following figure will show VIM4 trunk connection in case of 320G stacking:

Figure 7: VIM4 Connection for 320G Stacking



Selecting the Stacking Protocol

The Summit X440, X460, X480, X650, and X670 stacking ports can use either the standard or the enhanced stacking protocol. The default configuration selects the standard stacking protocol. The enhanced stacking protocol is required for MPLS.



NOTE

You must configure the enhanced stacking protocol on a stack before you can enable MPLS. Although you can mix Summit X460, X480, and X670 switches in a stack (MPLS is not supported on Summit X650 switches), Extreme Networks recommends that you do not mix these switch types if the desired routing table exceeds the supported limit for the Summit X460 switch, which is 12,256 IPv4 LPM routes.

To select the stacking protocol, use the command:

```
configure stacking protocol [standard | enhanced]
```

The new protocol selection activates the next time you reboot the switch.

Enabling the Stack

You can enable stacking through the command line interface (CLI).

Use the following command to enable the SummitStack feature on a node:

```
enable stacking {node-address <node-address>}
```

- If no parameters are specified, stacking is enabled on all nodes in the stack topology.
- If the node-address parameter is present, stacking is enabled on the node with the specified node-address. This is the MAC address assigned to the stackable switch by the factory. The `enable stacking` command takes effect only after you restart the node.
- A node that is booted with stacking enabled is said to be running in stacking mode.
- If stacking has never been configured or the configuration is inconsistent among the attached nodes, the command prompts you to perform an easy setup operation. If the easy setup option is not

offered and you want to perform an easy setup, use the `configure stacking easy-setup` command.

Use the `show stacking configuration` command to see the current configuration of this parameter as well as the value currently in use.

A node that is running in stacking mode attempts to join the active topology. If successful, it then negotiates a node role with the other nodes in the stack and becomes an operational node in the stack according to its role. The master node's configuration is applied to the node.

Verifying the Configuration

The `show slot` and `show stacking` commands contain stacking configuration information, including the state of the slot. These commands are also helpful when debugging stacking problems.

The `show slot` command shows the states of the nodes as they move from the empty to operational state. Use the `show slot` command and [Table 24](#) to determine a slot state:

```
Slot-1 Stack.25 # show slot
Slots      Type                Configured           State              Ports
-----
Slot-1     X450e-24p            X450e-24p           Operational        26
Slot-2     X450a-24t            X450a-24t           Operational        26
Slot-3     X450a-24tDC          X450a-24tDC         Operational        26
Slot-4     X450a-48t            X450a-48t           Operational        50
Slot-5     X450a-24x            X450a-24x           Operational        26
Slot-6     X450a-24xDC          X450a-24xDC         Operational        26
Slot-7     X450e-48p            X450e-48p           Operational        50
Slot-8     X450a-24t            X450a-24t           Operational        26
```

```
Slot-1 Stack.26 #
```

```
* Slot-1 Stack.1 # show stacking
Stack Topology is a Ring
Active Topology is a Ring
Node MAC Address      Slot  Stack State  Role      Flags
-----
*00:04:96:26:60:DD   1     Active      Master    CA-
00:04:96:26:60:EE   2     Active      Backup    CA-
00:04:96:26:60:FF   3     Active      Standby   CA-
00:04:96:26:60:AA   4     Active      Standby   CA-
00:04:96:26:60:88   5     Active      Standby   CA-
00:04:96:26:60:99   6     Active      Standby   CA-
00:04:96:26:60:BB   7     Active      Standby   CA-
00:04:96:26:60:CC   8     Active      Standby   CA-
* - Indicates this node
Flags: (C) Candidate for this active topology, (A) Active Node
       (O) node may be in Other active topology
```

The asterisk (*) that precedes the node MAC address indicates the node to which you are logged in.

The node MAC address is the address that is factory assigned to the stackable switch.

The slot number shown is the number currently in use by the related node. Since slot number configuration only takes effect during node initialization, a change in configured value alone does not cause a change to the slot number in use.

If a node role has not yet been determined, the node role indicates *<none>*. In a ring topology, the node on which this command is executed is always the first node displayed. In a daisy chain, the ends of the daisy chain are the first and last nodes displayed.

Even though the stack topology could be a ring, the active topology could be a daisy chain because it does not contain every node in the stack topology. If the node on which this command is being executed is not active, the line:

```
Active Topology is a ____
```

is replaced by the line:

```
This node is not in an Active Topology.
```



NOTE

It is possible for a node to be in Stabilizing or Waiting state and still be in the active topology.

Use the `show stacking configuration` command to get a summary of the stacking configuration for all nodes in the stack:

```
Slot-1 Stack.2 # show stacking configuration
Stack MAC in use: 02:04:96:26:6b:ed
Node          Slot      Alternate      Alternate
MAC Address   Cfg Cur Prio Mgmt IP / Mask    Gateway      Flags      Lic
-----
*00:04:96:26:6b:ed 1    1    Auto <none>      <none>      CcEeMm--- --
 00:04:96:34:d0:b8 2    2    Auto <none>      <none>      CcEeMm--- --

* - Indicates this node
Flags: (C) master-Capable in use, (c) master-capable is configured,
       (E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
       (M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
       (N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced
configured,
       (i) Stack MACs configured and in use are not the same or unknown,
       (-) Not in use or not configured
License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
                          (c) Core, (a) Advanced edge, or (e) Edge configured,
                          (-) Not in use or not configured
```

Use the `show stacking {node-address <node-address> | slot <slot-number>} detail` command to get a full report from the stacking database:

```
Slot-1 Stack.33 # show stacking slot 1 detail
Stacking Node 00:04:96:26:60:DD information:
Current:
  Stacking          : Enabled
  Role              : Master
  Priority          : 2
  Slot number      : 1
  Stack state      : Active
  Master capable   : Yes
  Stacking protocol : Enhanced
  License level restriction : Advanced edge
  In active topology? : Yes
  Factory MAC address : 00:04:96:26:60:DD
  Stack MAC address  : 02:04:96:26:60:DD
```

```

Alternate IP address      : 192.168.130.101/24
Alternate gateway        : 192.168.130.1
Stack port 1:
  State                  : Operational
  Blocked?               : No
  Control path active?   : Yes
Stack port 2:
  State                  : Operational
  Blocked?               : No
  Control path active?   : Yes
Configured:
Stacking                 : Enabled
Master capable           : Yes
Stacking protocol        : Enhanced
Slot number              : 1
Stack MAC address        : 02:04:96:26:60:DD
License level restriction : Edge

```

If you do not specify any node, the output is generated for all nodes in the stack topology. If the specified node does not exist, an error message appears.

The slot parameter is available only in stacking mode. The node-address parameter is always available.

Current information represents stacking states and configured values that are currently in effect. *Configured* information is that which takes effect at node reboot only.

The roles values are Master, Backup, Standby, and <none>. License level restrictions are Edge, Advanced Edge, or Core.

To verify the stack port states of each node in the stack topology use the command `show stacking stack-ports`.

Setting the Command Prompt

When stacking is enabled, the nodes inherit the SNMP sysname from the master.

The `configure snmp sysName` command affects the command prompt. The default setting on this command assigns the model name to the command prompt. When stacking is enabled, the current slot number is appended to the string, and the sysname is defaulted to *Stack*.

The command prompt looks similar to:

```
* Slot-6 Stack.21 #
```

The `*` indicates a changed and unsaved ExtremeXOS configuration. *Slot-6* indicates that the node is in stacking mode and is currently using slot number 6 in the active topology. The system name is the default *Stack*. The command to be executed is the 21st command entered since login, and you have logged in as the administrator on the master node (`#`).

The backup and the standby nodes show `>` instead of `#`. For example:

```
* Slot-6 Stack.23 >
```

If you have configured a *sysName* for the stack, each node in the active topology displays the configured *sysName* in its command prompt.

There is no specific prompt to indicate the node role. To discover the identities of the master and backup nodes, use the `show switch {detail}` or `show stacking` command.

Use the `show slot` command to verify the local switch type.

Configuring Slot Numbers

Each node in a stack must be assigned a slot number. The slot number must be unique to each node. You can assign the slot number only through configuration. The stack does not dynamically assign a slot number. The available slot numbers are 1 through 8.

You can specify a slot number for each node manually, or you can have the system assign the slot numbers using a single command.



NOTE

Slot numbers take effect only after a restart. If you change a slot number, the unit continues to operate with the slot number with which it was last restarted.

To manually add a slot number to a node, use the command `configure stacking node-address <node-address> slot-number <slot-number>`.

To configure the system to choose slot numbers for all nodes, enter the command `configure stacking slot-number automatic`.

Automatic slot number assignment is performed in the order of appearance of the nodes in the `show stacking` display. In the case of a ring topology, the first node in the display is the intended master node into which you have logged in.

Use the `show stacking` or `show stacking configuration` command to view the ordering and the assigned slot numbers.



NOTE

A node that boots in standalone mode does not use a slot number.

Configuring the Master, Backup, and Standby Roles

Each stack has a master node, and it might have a backup node and multiple standby nodes. The role of each stack node is determined by:

- The switch model number
- The configured priority value
- The configuration of the `master-capability` option (see “[Configuring Master-Capability](#)” on [page 179](#))

Some switch models have more memory and support additional features. To support the additional capabilities in a stack that includes multiple Summit switch models, the most capable switch

automatically becomes the master node. For this release, the ranking of Summit switch models is as follows:

- Summit X480 and X670 switches (most capable)
- Summit X650 switches
- All other Summit switches

If the stack configuration includes switches that are more capable than others, the stack will try to select the most-capable backup node. If a switch with reduced capabilities serves as the backup node for a switch with greater capabilities, that switch might not be able to support the stack as a master node if a failover occurs (for example, the less-capable switch might not have enough memory to store the master node configuration). If your configuration needs to support automatic failover, *Extreme Networks* recommends that if a stack contains mixed model numbers, one of the following configurations should be used:

- Identical, most-capable switches available to become the master and backup nodes
- The master-capability option is turned off for all *more-capable* switches

When all the master-capable nodes in a stack have the same model number, the node with the highest node role election priority becomes the master as a result of the first node role election, and the node with the second highest node role election priority becomes the backup node. All other nodes become standby nodes.

During subsequent node role elections that occur when a master node fails, the node priority configuration helps determine the node that becomes the replacement backup node.

Node priority configuration takes effect at the next node role election. A change in node priority configuration does not cause a new election. Once an active topology has elected a master node, that node retains the master node role until it fails or loses a dual master resolution.

You can configure one of the following election priority algorithms:

- Priority algorithm - If any node has a numeric priority value configured.
- Automatic algorithm - If all nodes participating in node role election have the automatic priority value configured.

The priority algorithm is selected if any node has a numeric priority value configured. You can specify an integer priority value between 1 and 100. The higher the value, the greater the node role election priority. If any node participating in a role election has a priority value configured, all nodes use the priority algorithm. A node configured with the automatic algorithm uses a priority value of zero (the lowest priority) in the priority algorithm if another node has a priority value configured.

The automatic algorithm is selected if no node participating in a role election has a numeric priority value configured. In automatic mode, the stack determines the highest role election priority based on factors such as available processing power, maintenance level of ExtremeXOS, and so forth.

In both algorithms, if the highest computed node role election priority is shared among multiple nodes, the slot number is used to adjust the node role election priority. A numerically lower slot number results in a higher role election priority than a numerically higher slot number. If you wish to use the slot number as the sole determining factor in node role election priority calculation, you should configure every node with the same priority value, and not *automatic*.

**NOTE**

Extreme Networks may change the behavior of the automatic priority algorithm in future ExtremeXOS releases.

Nodes that are configured as not master-capable do not participate in node role election. Priority configuration is not relevant on such nodes.

A dual master resolution does not use the configured node priority in most cases. Instead it uses the oldest time that a node became a master in the current active topology.

Use the following command to set the stacking node priority:

```
configure stacking {node-address <node-address> | slot <slot-number>} priority [<node-pri> | automatic]
```

Assigning a MAC Address for the Stack

The stack must use a single MAC address. When the master node fails over to the backup node, the backup node must continue to use the same MAC address that the master node was using.

Each stackable switch is assigned a single unique MAC address during production. By default, no stack MAC address is configured. You can choose any node to supply its factory assigned MAC address to form the stack MAC address.

When you assign a MAC address to a stack, one of the stackable switches is designated as the node whose factory assigned MAC address is used to form the stack MAC address. Once this is done, all nodes receive and store this formed MAC address in their own NVRAM. Whenever the stack boots up, this MAC address is used, regardless of which node is the master node.

**NOTE**

If new nodes are added to the stack, the new nodes must be configured with the stack MAC address. The easiest way to do this is to use the `synchronize stacking {node-address <node-address> | slot <slot-number>}` command.

Before being stored as the stack MAC address, the chosen node's factory assigned MAC address is converted to a *locally administered* MAC address. This prevents duplicate MAC address problems which lead to dual master situations. The chosen MAC address is put into effect only at node boot time. If the address needs to be changed on a single node, rebooting that node results in usage of the same address stack-wide.

If you do not configure the stack MAC address or it is not the same on all nodes, a warning message appears in the log.

Each node operates with whatever address is available (the configured stack MAC address or the node's factory assigned MAC address). If a master node fails over to the backup node, and the backup node's address is different than the one the former master node was using, the address is inconsistent with the addresses programmed into the packet forwarding hardware. The MAC address related to the management IP address changes to the one in use by the new master, but no gratuitous ARP requests are sent. In this case, it takes some time for hosts on the management network to flush the related ARP entry.

**NOTE**

If the node whose MAC address is chosen is removed from the stack with the intention of using the node elsewhere in the network, and that node is selected to supply the stack MAC in its new stack, the stack MAC of the original stack must be reconfigured to prevent a duplicate MAC address in the network.

To assign a MAC address to the stack, use the following procedure:

- 1 Use the `show stacking` configuration command to display the stack MAC address configuration.

```
Slot-1 stack.3 # show stacking configuration
Stack MAC in use: 00:04:96:26:6a:f1
Node          Slot      Alternate      Alternate
MAC Address   Cfg Cur Prio Mgmt IP / Mask    Gateway      Flags      Lic
-----
*00:04:96:26:6a:f1 1    1    11  10.127.4.131/24  10.127.4.254  CcEeMm---  Aa
00:04:96:26:6c:93 2    2    Auto 10.127.4.132/24  10.127.4.254  CcEeMm---  Aa
00:04:96:27:c8:c7 3    3    Auto 10.127.4.133/24  10.127.4.254  CcEeMm---  Aa
00:04:96:26:5f:4f 4    4    4    10.127.4.139/24  10.127.4.254  CcEeMm---  Aa
00:04:96:1f:a5:43 5    5    Auto 10.127.4.135/24  10.127.4.254  CcEeMm---  Aa
00:04:96:28:01:8f 6    6    6    10.127.4.136/24  10.127.4.254  CcEeMm---  Aa
00:04:96:20:b2:5c 7    7    Auto 10.127.4.137/24  10.127.4.254  CcEeMm---  Aa
00:04:96:26:6c:92 8    8    Auto 10.127.4.138/24  10.127.4.254  CcEeMm---  Aa
```

* - Indicates this node

Flags: (C) master-Capable in use, (c) master-capable is configured,
 (E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
 (M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
 (N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced
 configured,
 (i) Stack MACs configured and in use are not the same or unknown,
 (-) Not in use or not configured

License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
 (c) Core, (a) Advanced edge, or (e) Edge configured,
 (-) Not in use or not configured

The *MAC Address* column displays the factory MAC address for the node. The stack MAC address configuration information appears in the last three positions of the *Flags* column. As shown in the key at the bottom of the command display, the stack MAC configuration is displayed with the letters capital M, lower-case m, and lower-case i. If the flags read ---, the stack MAC address needs to be configured. If the flags read *Mm-*, the stack MAC address is already configured and in use.

- 2 To configure the stack to use the MAC address of the master, log in to the master console and enter the `configure stacking mac-address` command. For example:

```
Slot-1 stack.43 # configure stacking mac-address
```

This command will take effect at the next reboot of the specified node(s).

If you enter the `show stacking` command now, the stack MAC flags show `--i`, indicating that the stack MAC is configured and is not in use. After you restart the stack, the `i` disappears from the *Flags* column. To see if the stack MAC is consistently configured, enter the `show stacking {node-address <node-address> | slot <slot-number>} detail` command and compare all configured stack MAC addresses for equality. In this case, they should be equal.

- 3** To configure the stack to use a MAC address from a non-master node, log in to the master console and enter the `configure stacking {node-address <node-address> | slot <slot-number>} mac-address` command. For example:

```
Slot-1 stack.4 # configure stacking slot 2 mac-address
```

This command will take effect at the next reboot of the specified node(s).

- 4** Reboot the stack.

- 5** Verify the new stack mac address using the `show stacking` configuration command. The following example is based on the previous example:

```
Slot-1 stack.3 # show stacking configuration
```

```
Stack MAC in use: 00:04:96:26:6a:f1
```

Node MAC Address	Slot Cfg	Cur	Prio	Alternate Mgmt IP / Mask	Alternate Gateway	Flags	Lic
*00:04:96:26:6a:f1	1	1	11	10.127.4.131/24	10.127.4.254	CcEeMm---	Aa
00:04:96:26:6c:93	2	2	Auto	10.127.4.132/24	10.127.4.254	CcEeMm---	Aa
00:04:96:27:c8:c7	3	3	Auto	10.127.4.133/24	10.127.4.254	CcEeMm---	Aa
00:04:96:26:5f:4f	4	4	4	10.127.4.139/24	10.127.4.254	CcEeMm---	Aa
00:04:96:1f:a5:43	5	5	Auto	10.127.4.135/24	10.127.4.254	CcEeMm---	Aa
00:04:96:28:01:8f	6	6	6	10.127.4.136/24	10.127.4.254	CcEeMm---	Aa
00:04:96:20:b2:5c	7	7	Auto	10.127.4.137/24	10.127.4.254	CcEeMm---	Aa
00:04:96:26:6c:92	8	8	Auto	10.127.4.138/24	10.127.4.254	CcEeMm---	Aa

* - Indicates this node

Flags: (C) master-Capable in use, (c) master-capable is configured,
(E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
(M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
(N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced
configured,

(i) Stack MACs configured and in use are not the same or unknown,
(-) Not in use or not configured

License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
(c) Core, (a) Advanced edge, or (e) Edge configured,
(-) Not in use or not configured

Configuring Master-Capability

Each node is configurable to be *master-capable* or not. This means that a node can either be allowed to take on any node role, or be restricted to executing the standby node role only. The default is that a node can take on any role. The restriction is used to avoid the dual master condition. A master-capability configuration change takes effect at the next restart.

You can use any of the following commands to configure the master-capability:

- `configure stacking [node-address <node-address> | slot <slot-number>] master-capability [on | off]`
- `configure stacking redundancy [none | minimal | maximal]`

Using these commands, you can configure one or more nodes to be allowed to operate either as a master or a backup.

The `configure stacking master-capability` command allows you to set the master-capability of specific nodes, while `configure stacking redundancy` allows you to set the master-capability on all nodes in the stack.

The commands do not allow you to disable master-capability on all nodes in a stack topology.

**NOTE**

If the entire stack is restarted in stacking mode without any node having master capability, you need to know the failsafe account and password to log into any node in the stack. If you do not know the failsafe account information, you might need to *rescue* the stack. See [“Rescuing a Stack That Has No Master-Capable Node” on page 214](#).

Configuring an Alternate IP Address and Gateway

The stack has a primary IP address and subnetwork that is configured with the `configure vlan mgmt ipaddress` command, and there may also be static or default routes associated to it. For each node in the stack, you can configure an alternate management IP address, subnetwork mask, and default gateway. The alternate IP address is restricted to being a member of the primary IP subnetwork that is configured on the management VLAN, and thus the alternate IP subnetwork must exactly match the primary IP management subnetwork. A subnetwork match is exact if the subnetwork portion of the IP addresses match exactly. For example, 10.11.12.1/24 and 10.11.12.2/24 are an exact subnetwork match (because both represent the subnet 10.11.12.0/24).

Standby nodes always install their configured alternate management IP address and gateway on the management interface. A standby node does not have the ability to verify whether the configured alternate IP address matches the primary management IP subnetwork of the stack.

The backup and master nodes have the ability to verify the configured alternate IP address. The master and backup nodes compare the primary IP subnetwork information to the alternate IP subnetwork. If there is a match, the backup node installs the primary IP management subnetwork’s default routes and installs only the alternate management IP address (not the primary IP address). The master node installs both the configured management subnetwork with specific IP address and the alternate IP address. In this case, the alternate gateway is not used, expecting that primary management routes are configured or will be configured. In either case, if the alternate IP subnetwork does not match the configured management subnetwork, the alternate IP address is not installed on the management interface.

Each node in the stack normally installs its alternate IP address on the management subnetwork. When an ARP request for the alternate IP address is satisfied, the stackable switch supplies its factory assigned MAC address and not the stack MAC address. Only the master node installs the primary IP address. An ARP request for the configured management IP address returns the configured stacking MAC address. Because of the above behavior, all nodes are reachable over their management ports even during a dual master situation. The VLAN used is the management VLAN (VID 4095) and is untagged.

The alternate gateway is only installed on a master or backup node when the primary management IP subnetwork is not configured. Once the primary IP subnetwork is installed, the alternate gateway is removed. The alternate gateway is always installed on a standby node.

If a dual master situation occurs because of a stack severance, the alternate IP addresses and associated MAC addresses are unique, and it is possible to use telnet or ssh to reach any node. Any node on the segment with the incorrect master can then be used to reboot the entire stack segment into standby mode if you want to rejoin the stack segments later.

If a node is operating in stacking mode, the alternate management IP address configuration takes effect immediately.

**NOTE**

Only IPv4 alternate management IP addresses are supported in this release.

To configure an alternate IP address and gateway, use the following procedure:

1 View the alternate IP address configuration using the `show stacking configuration` command:

```
Slot-1 stack.13 # show stacking configuration
Stack MAC in use: 00:04:96:26:6a:f1
Node          Slot      Alternate      Alternate
MAC Address   Cfg Cur Prio Mgmt IP / Mask Gateway      Flags      Lic
-----
*00:04:96:26:6a:f1 1    1    11  <none>      <none>      CcEeMm--- Aa
00:04:96:26:6c:93 2    2    Auto <none>      <none>      CcEeMm--- Aa
00:04:96:27:c8:c7 3    3    Auto <none>      <none>      CcEeMm--- Aa
00:04:96:26:5f:4f 4    4    4    <none>      <none>      CcEeMm--- Aa
00:04:96:1f:a5:43 5    5    Auto <none>      <none>      CcEeMm--- Aa
00:04:96:28:01:8f 6    6    6    <none>      <none>      CcEeMm--- Aa
00:04:96:20:b2:5c 7    7    Auto <none>      <none>      CcEeMm--- Aa
00:04:96:26:6c:92 8    8    Auto <none>      <none>      CcEeMm--- Aa
```

* - Indicates this node

Flags: (C) master-Capable in use, (c) master-capable is configured,
 (E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
 (M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
 (N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced
 configured,
 (i) Stack MACs configured and in use are not the same or unknown,
 (-) Not in use or not configured

License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
 (c) Core, (a) Advanced edge, or (e) Edge configured,
 (-) Not in use or not configured

In the example above, no alternate IP address or alternate gateway is configured.

2 If you have a continuous block of IP addresses to assign to the stack, enter the `configure stacking alternate-ip-address [<ipaddress> <netmask> | <ipNetmask>] <gateway> automatic` command. For example:

```
Slot-1 Stack.14 # configure stacking alternate-ip-address 10.127.4.131/24 10.127.4.254
automatic
```

```
Slot-1 Stack.15 # show stacking configuration
Stack MAC in use: 00:04:96:26:6a:f1
Node          Slot      Alternate      Alternate
MAC Address   Cfg Cur Prio Mgmt IP / Mask Gateway      Flags      Lic
-----
*00:04:96:26:6a:f1 1    1    11  10.127.4.131/24 10.127.4.254 CcEeMm--- Aa
00:04:96:26:6c:93 2    2    Auto 10.127.4.132/24 10.127.4.254 CcEeMm--- Aa
00:04:96:27:c8:c7 3    3    Auto 10.127.4.133/24 10.127.4.254 CcEeMm--- Aa
00:04:96:26:5f:4f 4    4    4    10.127.4.134/24 10.127.4.254 CcEeMm--- Aa
00:04:96:1f:a5:43 5    5    Auto 10.127.4.135/24 10.127.4.254 CcEeMm--- Aa
00:04:96:28:01:8f 6    6    6    10.127.4.136/24 10.127.4.254 CcEeMm--- Aa
00:04:96:20:b2:5c 7    7    Auto 10.127.4.137/24 10.127.4.254 CcEeMm--- Aa
00:04:96:26:6c:92 8    8    Auto 10.127.4.138/24 10.127.4.254 CcEeMm--- Aa
```

* - Indicates this node

Flags: (C) master-Capable in use, (c) master-capable is configured,
 (E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
 (M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
 (N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced
 configured,
 (i) Stack MACs configured and in use are not the same or unknown,
 (-) Not in use or not configured

License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
 (c) Core, (a) Advanced edge, or (e) Edge configured,
 (-) Not in use or not configured

3 If you do not have a continuous block of IP addresses for the stack, assign an alternate IP address and gateway to each node using the `configure stacking [node-address <node-address> | slot <slot-number>] alternate-ip-address [<ipaddress> <netmask> | <ipNetmask>] <gateway>` command. For example:

```
Slot-1 Stack.18 # configure stacking slot 4 alternate-ip-address 10.127.4.139/24
10.127.4.254
```



NOTE

If you try to assign an alternate IP address and gateway to a node that is already configured with these parameters, an error message appears. To remove an existing configuration so you can change the alternate IP address and gateway, enter the `unconfigure stacking {node-address <node-address> | slot <slot-number>} alternate-ip-address` command.

4 Enter the `show stacking` configuration command to verify that the alternate IP address and gateway is configured as intended for each node.

```
Slot-1 Stack.19 # show stacking configuration
Stack MAC in use: 00:04:96:26:6a:f1
Node          Slot      Alternate      Alternate
MAC Address   Cfg Cur  Prio Mgmt IP / Mask  Gateway      Flags      Lic
-----
*00:04:96:26:6a:f1 1    1    11  10.127.4.131/24  10.127.4.254  CcEeMm--- Aa
00:04:96:26:6c:93 2    2    Auto 10.127.4.132/24  10.127.4.254  CcEeMm--- Aa
00:04:96:27:c8:c7 3    3    Auto 10.127.4.133/24  10.127.4.254  CcEeMm--- Aa
00:04:96:26:5f:4f 4    4    4    10.127.4.139/24  10.127.4.254  CcEeMm--- Aa
00:04:96:1f:a5:43 5    5    Auto 10.127.4.135/24  10.127.4.254  CcEeMm--- Aa
00:04:96:28:01:8f 6    6    6    10.127.4.136/24  10.127.4.254  CcEeMm--- Aa
00:04:96:20:b2:5c 7    7    Auto 10.127.4.137/24  10.127.4.254  CcEeMm--- Aa
00:04:96:26:6c:92 8    8    Auto 10.127.4.138/24  10.127.4.254  CcEeMm--- Aa
```

* - Indicates this node

Flags: (C) master-Capable in use, (c) master-capable is configured,
 (E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
 (M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
 (N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced
 configured,
 (i) Stack MACs configured and in use are not the same or unknown,
 (-) Not in use or not configured

License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
 (c) Core, (a) Advanced edge, or (e) Edge configured,
 (-) Not in use or not configured

Configuring the Failsafe Account on a Stack

The failsafe account information is stored in each node's local NVRAM.

To change the failsafe account, use the command `configure failsafe-account {[deny | permit] [all | control | serial | ssh {vr <vr-name>} | telnet {vr <vr-name>}]}` from the master node.

This command changes the account information in the NVRAM of every active node in the same active topology. If a new node is added later, you can use the `synchronize stacking {node-address <node-address> | slot <slot-number>}` command to copy the failsafe account information from the master to the new node.

Disabling Stacking

To disable stacking on a member of stack, use the following command:

```
disable stacking {node-address <node-address>}
```

Rebooting the node with stacking disabled causes it to run in standalone mode.

A node that is running in standalone mode becomes its own master and processes its own configuration.

By default, stacking is disabled on all nodes.

Saving the Configuration

The ExtremeXOS configuration file is saved to every active node when you use the `save configuration {primary | secondary | <existing-config> | <new-config>}` command on the master.

The stacking specific configuration parameters for a node are saved in the NVRAM of the node when you run the configuration commands. Stacking configuration parameters are not saved in the ExtremeXOS configuration file.

Managing an Operating Stack

This section describes the following topics and tasks:

- [Managing Licenses on a Stack on page 184](#)
- [Stacking LEDs on page 187](#)
- [Viewing the Alternate IP Address on page 187](#)
- [Viewing Stacking Port Statistics on page 189](#)
- [Adding a Node to a Stack on page 189](#)
- [Replacing a Node with the Same Switch Type on page 192](#)
- [Replacing a Node with a Different Switch Type on page 194](#)
- [Merging Two Stacks on page 195](#)
- [Upgrading ExtremeXOS on a Stack on page 201](#)

- [Upgrading SummitStack Option Cards on page 203](#)
- [Dismantling a Stack on page 207](#)
- [Removing a Node from a Stack on page 208](#)
- [Rebooting a Stack on page 209](#)

Managing Licenses on a Stack

The SummitStack feature is not licensed separately. You can use the SummitStack feature with an Edge license.



NOTE

For successful operation, all master-capable nodes in a stack must be at or above the license level on the master node, and all feature packs installed on the master node must also be installed on the master-capable nodes.

The rules for licensing are:

- At startup, the license level the stack uses is the effective license level of the elected master node.
 - If the stack is using the Advanced Edge license and you attempt to add a master-capable node that is using an Edge license, the node does not become operational and shows as Failed with a License Mismatch reason when using the `show slot {<slot> {detail} | detail }` command.
- License mismatch detection is continually checked in master-capable nodes.
 - If master-capable nodes of different license levels are operational in the stack and there is a failover to a backup node that has a level that is not the same as that of the failed master, the stack operating license level changes to the effective license level of the new master. If any other master-capable node is using an effective license level that is not the same as that of the new master, the node fails with a license mismatch.
- Nodes with higher licenses levels than other nodes can be restricted to operate at a lower or effective license level.

The following sections describe license management in a stack:

- [Viewing Switch Licenses and License Restrictions on page 184](#)
- [Enabling a Switch License on page 185](#)
- [Restricting a Switch License Level on page 186](#)
- [Upgrading Stack Licenses on page 186](#)

Viewing Switch Licenses and License Restrictions

To view the current license information for a node, log into that node and enter the `show licenses` command. The command display is similar to the following:

```
Slot-1 Stack.1 # show licenses
Enabled License Level:
    Advanced Edge
Enabled Feature Packs:
    None
Effective License Level:
    Advanced Edge
Slot-1 Stack.2 #
```

The *Enabled License Level* is the purchased license level. This is the maximum level at which this node can operate without purchasing a license level upgrade.

The *Effective License Level* is the operating license level. If a license level restriction is configured for this node, the effective license level may be lower than the enabled license level. All master-capable switches must be operated at the same effective license level.

To view the license level restrictions configured for all nodes in a stack, log in to the master node and enter the `show stacking configuration` command:

```
Slot-1 Stack.33 # show stacking configuration
Stack MAC in use: 02:04:96:26:60:DD
Node          Slot      Alternate      Alternate
MAC Address   Cfg Cur Prio Mgmt IP / Mask     Gateway      Flags      Lic
-----
*00:04:96:26:60:DD 1    1    Auto 192.168.130.101/24 192.168.130.1  CcEeMm---  Aa
00:04:96:26:60:EE 2    2    Auto 192.168.130.102/24 192.168.130.1  CcEeMm---  Aa
00:04:96:26:60:FF 3    3    Auto 192.168.130.103/24 192.168.130.1  --EeMm---  Aa
00:04:96:26:60:AA 4    4    Auto 192.168.130.104/24 192.168.130.1  --EeMm---  Aa
00:04:96:26:60:88 5    5    Auto 192.168.130.105/24 192.168.130.1  --EeMm---  Aa
00:04:96:26:60:99 6    6    Auto 192.168.130.106/24 192.168.130.1  --EeMm---  Aa
00:04:96:26:60:BB 7    7    Auto 192.168.130.107/24 192.168.130.1  --EeMm---  Aa
00:04:96:26:60:CC 8    8    Auto 192.168.130.108/24 192.168.130.1  --EeMm---  Aa
```

* - Indicates this node

Flags: (C) master-Capable in use, (c) master-capable is configured,
 (E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
 (M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
 (N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced
 configured,

(i) Stack MACs configured and in use are not the same or unknown,
 (-) Not in use or not configured

License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
 (c) Core, (a) Advanced edge, or (e) Edge configured,
 (-) Not in use or not configured

License level restrictions appear in the *Lic* column. The license level restriction in use appears first, represented by a capital letter as shown in the display legend. The configured license level restriction appears second, represented by a lower-case letter. When the letters in the *Lic* column are different, for example Ae, the node is configured with a different license level restriction than the one that is currently in use. To put the configured license level restriction into effect, you must reboot the node.

Enabling a Switch License

The purchased license level of a node can be enabled only after you log in to that node (see [“Logging Into a Node From Another Node” on page 154](#)). For instructions on enabling a license on a node, see [Appendix B, “Software Upgrade and Boot Options.”](#)



NOTE

All nodes must have a purchased license level at least equal to the license level of the master node in order to become operational in the stack.

Restricting a Switch License Level

If the master-capable nodes in a stack have different license levels and you want to operate a stack at the minimum license level, you can apply a license level restriction. The restriction is stored in the NVRAM of each master-capable node. It forces the node to reduce its license level below its purchased level at node restart time for the life of the restart. This reduced license level is called the *effective license level* and can be displayed by entering the `show licenses` command on the node you want to evaluate.

To restrict a master-capable node to operate at a license level that is lower than the one purchased for the node, use the command:

```
configure stacking {node-address <node-address> | slot <slot-number>} license-level
[core | advanced-edge | edge]
```

In the following example, node 7 is restricted to operate at the Edge license level:

```
* X450a-24x.7 # configure stacking slot 7 license-level edge
This command will take effect at the next reboot of the specified node(s).
```

You must reboot the master-capable node for the command to take effect. The command restricts the specified node to operate at the specified license level. The specified license level must match the effective license level of all master-capable nodes in the stack. To avoid stack reboots when future license level upgrades are purchased, during initial deployment you should purchase the same license level for every master-capable node in the stack, and the license level restriction should not be configured.

Upgrading Stack Licenses

You can purchase license level upgrades for Summit family switches. All master-capable switches in a stack must run the same license level. If the license you want to run is not available for a specific Summit switch, you cannot use that switch and that license level as a master-capable switch. For example, if you want to upgrade to the core license, your master-capable nodes must be Summit family switches that support the core license.



NOTE

See [Appendix A, “Feature License Requirements,”](#) for information on which switches support which licenses. This appendix also lists which switches support the SummitStack feature.

Use the following procedure to upgrade switch licenses:

- 1 Log in to the master node.
- 2 Enter the `show stacking` command and note the role (master, backup, or standby) of each node in the stack.
- 3 Enter the `show stacking configuration` command and note any nodes that are configured with a license level restriction (see [“Viewing Switch Licenses and License Restrictions” on page 184](#)).
- 4 Install the required license level in each master-capable node (backup and standby nodes) by logging into each node (`telnet slot <slot-number>`) and entering the command:

```
enable license {software} <key>
```

Enter the license key given to you by Extreme Networks when you purchased the upgrade.

- 5 Use the commands in Step 4 to install the required license level on the master node.

- If any nodes are configured with a license level restriction that is lower than the intended operating license level of the stack, log into the master node and remove the stack license level restriction using the command:

```
unconfigure stacking license-level
```

This command removes the restriction on all nodes.

- If you removed a license level restriction in Step 7, reboot the stack to put the license level restriction removal into effect using the command:

```
reboot {[time <mon> <day> <year> <hour> <min> <sec>] | cancel} {slot <slot-number> | node-address <node-address> | stack-topology {as-standby}}
```

- Verify that all master-capable nodes are operating at the intended license level. To do this, use the `show licenses` command and `show slot {<slot> {detail} | detail }` command on the master node. If no slot shows as *Failed*, then all master-capable nodes are operating at the effective license level shown for the master node.

Stacking LEDs

All stackable switches have a seven segment LED.

The seven segment LED on Summit X250, X440, X460, X480, X650, and X670 series switches behaves as follows:

- LED dark—Stackable switch is not in stacking mode
- Slot number displayed, top half blinking—Stack master
- Slot number displayed, bottom half blinking—Stack backup
- Slot number display solid—Standby node

When in stacking mode, the slot number is displayed shortly after the node begins initializing and remains in the display until a restart occurs.

The stacking ports have LEDs that behave the same as the data port LEDs. The stacking port LEDs can be in the states shown in [Table 24](#), even if the unit is not in a stacking mode.

Table 24: Stacking LED States

State	Description
Off	No signal
Solid Green	Signal present
Flickering Green	Traffic through the port

While in a stack, the remaining LEDs (Mgmt, Fan, PSU-I, and PSU-E) on the unit operate normally.

Viewing the Alternate IP Address

To view the alternate IP address for a node, you can use the following commands:

- `show vlan mgmt`
- `show ipconfig Mgmt`

show vlan mgmt Command

The `show vlan mgmt` command shows the alternate management IP address as applied to the management VLAN on the local unit. This allows you to see how the configured alternate management IP address has been applied.

The `show vlan mgmt` command displays the following information:

```
Slot-1 Stack.35 # show vlan "Mgmt"
VLAN Interface with name Mgmt created by user
  Admin State:   Enabled           Tagging:      802.1Q Tag 4095
  Virtual router: VR-Mgmt
  Primary IP:    10.1.4.1/24
  Alternate IP:  10.1.4.2/24
  IPv6:         None
  STPD:         None
  Protocol:     Match all unfiltered protocols
  Loopback:     Disabled
  NetLogin:     Disabled
  QosProfile:   None configured
  Ports:        1.                (Number of active ports=1)
  Untag: Mgmt-port on Mgmt-? is active
```

For the management VLAN, a secondary address cannot be configured and so the *Secondary IP* line does not appear. The *Alternate IP* line shows one of the following:

- The configured alternate management IP address if it has been activated
- *<none>* if it has not been configured
- *Mismatch* if it has been configured but does not exactly match the *Primary IP* subnet.

show ipconfig mgmt Command

The `show ipconfig mgmt` command shows the configured alternate management IP address as applied to the management VLAN on the local unit. This allows you to see how the configured alternate management IP address has been applied.

The *Multinetted VLAN* indication always appears as *no*. The alternate IP address is restricted to the same subnet as the primary subnet configured for the management IP interface. As a result, only a single subnet is used with the possibility of multiple station addresses. Further, you cannot configure a secondary IP address on the management VLAN.

The `show ip config mgmt` command displays the following information:

```
Slot1 Stack.36 # show ipconfig Mgmt
Router Interface on VLAN Mgmt is enabled and up.
  inet 10.66.4.74/24 broadcast 10.66.4.255 Mtu 1500
  Alternate IP Address: 10.66.4.75/24
  Flags:
    AddrMaskRly NO      BOOTP Host NO      DirBcstHwFwd NO      Fwd Bcast NO
    IgnoreBcast NO      IP Fwding NO      IPmc Fwd NO Multinetted VLAN NO
    IRDP Advert NO      SendParam YES      SendPortUn YES      Send Redir YES
    SendTimxceed YES    SendUnreach YES    TimeStampRly NO      VRRP NO
```

For the management VLAN, a secondary address cannot be configured and so the *Secondary IP* line does not appear. The *Alternate IP Address* line shows one of the following:

- The configured alternate management IP address if it has been activated
- *<none>* if it has not been configured
- *Mismatch* if it has been configured but does not exactly match the *Primary IP* subnet.

Viewing Stacking Port Statistics

To view the status of any stacking port, use the following command variations:

```
show ports stack-ports <stacking-port-list> utilization {bandwidth | bytes | packets}
show ports {stack-ports <stacking-port-list> | <port-list>} statistics {norefresh}
show ports {<port-list> | stack-ports <stacking-port-list>} rxerrors {norefresh}
show ports {stack-ports <stacking-port-list> | <port-list>} txerrors {norefresh}
```

The commands accept stacking port ranges that span multiple nodes. There are no stack port configuration options.

There is no way to disable a stacking port. These ports are always enabled.

Adding a Node to a Stack

From the perspective of a new node, adding a node to an active topology is similar to bringing up a new stack. To add a node to a stack, use the following procedure.



NOTE

If the node being added is actually a replacement node for one that was previously removed, see [“Replacing a Node with the Same Switch Type” on page 192](#) or [“Replacing a Node with a Different Switch Type” on page 194](#).

- 1 Review the general and model-specific configuration guidelines for the switch you are installing. These guidelines are described in [“Stack Configuration Guidelines” on page 154](#).
- 2 Before connecting the switch to the stack, prepare the switch as follows:
 - a Review the guidelines for the switch you are installing. These guidelines are described in [“Stack Configuration Guidelines” on page 154](#).
 - b With the power off, install any required option cards as described in the *Summit Family Switches Hardware Installation Guide*.
 - c Power on the new node.
 - d Use the `show switch` command to verify that the new node is using the same ExtremeXOS software version as the stack to which it will be added. If it is not using the correct version, install the correct version.
 - e Use the `show switch` command to verify that the ExtremeXOS software is booted on the same image (primary or secondary) on which the stack is booted. If the new node is booted on a different image, change the image before you continue.
 - f Use the `enable stacking` command to enable stacking; then decline the easy setup option.
 - g Configure a unique slot number for the new node (see [“Configuring Slot Numbers” on page 175](#)). Select a slot number that is not already in use in the stack to which this node will be added.

- h** Configure the node's master-capability to correspond to the role it should have in the stack (see [“Configuring Master-Capability” on page 179](#)).
 - i** If the new node will operate as a master-capable node, use the `show licenses` command to verify that the enabled license level is at the same level as the master-capable nodes in the stack. If necessary, configure the license-level restriction of the new node to be same as the other master-capable nodes in the stack (see [“Managing Licenses on a Stack” on page 184](#)).
 - j** Configure the node role priority to correspond to the priority it should have in the stack (see [“Configuring the Master, Backup, and Standby Roles” on page 175](#)).
 - k** Configure an alternate IP address and gateway (see [“Configuring an Alternate IP Address and Gateway” on page 180](#)).
 - l** If the new node is a Summit X650 switch, configure the switch to use the stacking ports as described in [“Enabling and Disabling Stacking Support for Summit X650 and X670 Switches” on page 166](#).
 - m** If the new node is a Summit X650 switch with a VIM3-40G4X option card, configure the option card ports as described in [“Configuring Stacking Port Operation with the VIM3-40G4X Option Card” on page 170](#).
 - n** If the new node is a Summit X670V switch with a VIM4-40G4X option card, configure the option card ports as described in [“Configuring Stacking Port Operation with the VIM4-40G4X Option Card” on page 170](#).
 - o** If the new node will use the SummitStack-V feature, configure the alternate stack ports as described in [“Using Ethernet Ports for Stacking \(SummitStack-V\)” on page 167](#).
 - p** If the stack will use MPLS, the stack must contain only Summit X460, X480, and X670 switches, and you must configure all stack switches to use the enhanced stacking protocol as described in [“Selecting the Stacking Protocol” on page 171](#).
- 3** Connect the stacking links to the new node and use the `reboot` command to reboot the node. For cabling instructions, see the *Summit Family Switches Hardware Installation Guide*.
 - 4** At the stack master node, run the `synchronize stacking {node-address <node-address> | slot <slot-number>}` command and do not specify either a node-address or a slot.
 - 5** Reboot the new node by entering the `reboot slot [<slot-number> | node-address <node-address>]` command.
 - 6** (Optional) Run the `show stacking configuration` command and verify that the configuration is what you want.

Example: Adding a Node to a Stack

Assume the original stack is connected as follows:

```
Slot-1 Stack.9 # show stacking stack-ports
Stack Topology is a Ring
Slot Port Select Node MAC Address Port State Flags Speed
-----
*1 1 Native 00:04:96:26:6a:f1 Operational C- 10G
*1 2 Native 00:04:96:26:6a:f1 Operational C- 10G
  2 1 Native 00:04:96:26:6c:93 Operational C- 10G
  2 2 Native 00:04:96:26:6c:93 Operational C- 10G
  3 1 Native 00:04:96:26:5f:4f Operational C- 10G
  3 2 Native 00:04:96:26:5f:4f Operational CB 10G
  4 1 Native 00:04:96:1f:a5:43 Operational CB 10G
  4 2 Native 00:04:96:1f:a5:43 Operational C- 10G
  5 1 Native 00:04:96:28:01:8f Operational C- 10G
  5 2 Native 00:04:96:28:01:8f Operational C- 10G
  6 1 Native 00:04:96:20:b2:5c Operational C- 10G
  6 2 Native 00:04:96:20:b2:5c Operational C- 10G
* - Indicates this node
Flags: (C) Control path is active, (B) Port is Blocked
```

The following commands add a seventh node to the stack:

```
* Switch.3 # enable stacking
This command will take effect at the next reboot of the specified node(s).

# Display the node MAC address
* Switch.4 # show stacking
Stack Topology is a Daisy-Chain
This node is not in an Active Topology
Node MAC Address Slot Stack State Role Flags
-----
*00:04:96:26:6c:92 - Disabled Master ---
* - Indicates this node
Flags: (C) Candidate for this active topology, (A) Active Node
       (O) node may be in Other active topology

# Configure a unique slot number
Switch.5 # configure stacking node-address 00:04:96:26:6c:92 slot-number 7
This command will take effect at the next reboot of the specified node(s).

Switch.6 # configure stacking node-address 00:04:96:26:6c:92 license-level edge
This command will take effect at the next reboot of the specified node(s).
```

Connect the new switch to the stack using a stacking cable to join the stacking ports and form a physical ring. The connections should be made such that the node appears in the natural position in the stack and in the slot. The example below adds a new node that becomes slot 7.

- The connection broken should be the one between node 00:04:96:20:b2:5c port 2 and node 00:04:96:26:6a:f1 port 1.
- The new node 00:04:96:26:6c:92 port 1 should be connected to node 00:04:96:20:b2:5c port 2
- The new node 00:04:96:26:6c:92 port 2 should be connected to node 00:04:96:26:6a:f1 port 1.

```
Switch.7 # reboot
```

```
# Log into the stack master node before entering the next command
Slot-1 Stack.13 # synchronize stacking node-address 00:04:96:26:6c:92
```

```
Slot-1 Stack.13 # reboot node-address 00:04:96:26:6c:92
Are you sure you want to reboot this stack node? (y/N) Yes
```

```
Slot-1 Stack.18 # show stacking
```

```
Stack Topology is a Ring
```

```
Active Topology is a Ring
```

Node MAC Address	Slot	Stack State	Role	Flags
*00:04:96:26:6a:f1	1	Active	Master	CA-
00:04:96:26:6c:93	2	Active	Standby	CA-
00:04:96:26:5f:4f	3	Active	Backup	CA-
00:04:96:1f:a5:43	4	Active	Standby	CA-
00:04:96:28:01:8f	5	Active	Standby	CA-
00:04:96:20:b2:5c	6	Active	Standby	CA-
00:04:96:26:6c:92	7	Active	Standby	CA-

```
* - Indicates this node
```

```
Flags: (C) Candidate for this active topology, (A) Active Node
(O) node may be in Other active topology
```

```
Slot-1 stack.19 # show slot
```

Slots	Type	Configured	State	Ports
Slot-1	X450a-48t	X450a-48t	Operational	50
Slot-2	X450a-24x	X450a-24x	Operational	26
Slot-3	X450a-24t	X450a-24t	Operational	26
Slot-4	X450a-24x	X450a-24x	Operational	26
Slot-5	X450a-24t	X450a-24t	Operational	26
Slot-6	X450a-24x	X450a-24x	Operational	26
Slot-7	X450a-24x	X450a-24x	Operational	26
Slot-8			Empty	0

Replacing a Node with the Same Switch Type

When you replace a node with the same switch type, for example when you replace a Summit X450a-48t with a Summit X450a-48t, you can continue to use the same stack configuration. The procedure in this section works only when the old and new nodes have identical switch types.



NOTE

If you are replacing a node with a different switch type, you must change the stack configuration before the new node can operate. For more information, see [“Replacing a Node with a Different Switch Type”](#) on page 194.



NOTE

The Summit Stack X440, X460, X480, and X650 configured via [“configure stacking easy-setup”](#) use the enhanced stacking protocol by default. While replacing a node in Summit Stack X440, X460, X480 or X650 configured with the enhanced stacking protocol, be sure to add [“configure stacking protocol”](#) enhanced before joining active stack topology.

To replace a node with an identical switch type:

- 1 Use the `show switch`, `show licenses`, and `show stacking configuration` commands to display configuration information for the node to be replaced. Note the following about the switch you are replacing:
 - ExtremeXOS software version
 - Partition on which the switch is booted
 - Effective license level for the stack
 - Slot number
 - Stacking protocol; standard or enhanced?
 - Master-capable feature configuration
 - Node priority
 - Alternate gateway IP address
- 2 Remove the stack links from the node to be replaced.
- 3 Replace the node with the same type of node.
- 4 Before connecting the replacement switch to the stack, prepare the switch as follows:
 - a Review the guidelines for the switch you are installing. These guidelines are described in [“Stack Configuration Guidelines” on page 154](#).
 - b With the power off, install any required option cards as described in the *Summit Family Switches Hardware Installation Guide*.
 - c Power on the replacement node.
 - d Use the `show switch` command to verify that the replacement node is using the same ExtremeXOS software version as the stack in which it will be added. If it is not using the correct version, install the correct version.
 - e Use the `show switch` command to verify that the ExtremeXOS software is booted on the same image (primary or secondary) on which the stack is booted. If the new node is booted on a different image, change the image before you continue.
 - f Use the `enable stacking` command to enable stacking; then decline the easy setup option.
 - g Configure the slot number for the replacement node using the slot number noted in Step 1. (See [“Configuring Slot Numbers” on page 175](#).)
 - h If the replaced node was using the enhanced stacking protocol, use the `configure stacking protocol` command to select that protocol.
 - i Configure the node's master-capability to correspond to the value noted in Step 1. (see [“Configuring Master-Capability” on page 179](#)).
 - j If the replacement node will operate as a master-capable node, use the `show licenses` command to verify that the enabled license level is at the same level as the master-capable nodes in the stack. If necessary, configure the license-level restriction of the new node to be same as the other master-capable nodes in the stack (see [“Managing Licenses on a Stack” on page 184](#)).
 - k Configure the node role priority to correspond to the priority it should have in the stack (see [“Configuring the Master, Backup, and Standby Roles” on page 175](#)).
 - l Configure an alternate IP address and gateway (see [“Configuring an Alternate IP Address and Gateway” on page 180](#)).
 - m If the new node is a Summit X650 switch, configure the switch to use the stacking ports as described in [“Enabling and Disabling Stacking Support for Summit X650 and X670 Switches” on page 166](#).

- n If the new node is a Summit X650 switch with a VIM3-40G4X option card, configure the option card ports as described in [“Configuring Stacking Port Operation with the VIM3-40G4X Option Card” on page 170.](#)
 - o If the new node is a Summit X670V switch with a VIM4-40G4X option card, configure the option card ports as described in [“Configuring Stacking Port Operation with the VIM4-40G4X Option Card” on page 170.](#)
 - p If the new node will use the SummitStack-V feature, configure the alternate stack ports as described in [“Using Ethernet Ports for Stacking \(SummitStack-V\)” on page 167.](#)
 - q If the stack will use MPLS, the stack must contain only Summit X460, X480, and X670 switches, and you must configure all stack switches to use the enhanced stacking protocol as described in [“Selecting the Stacking Protocol” on page 171.](#)
- 5 Connect the stack links and reboot the node. The switch should join the stack topology. For cabling instructions, see the *Summit Family Switches Hardware Installation Guide*.
 - 6 At the stack master node, run the `synchronize stacking {node-address <node-address> | slot <slot-number>}` command and do not specify either a node-address or a slot.

**NOTE**

If the master node was replaced, log into another stack node before entering this command.

- 7 Reboot the new node by entering the `reboot slot [<slot-number> | node-address <node-address>]` command.

**NOTE**

If the master node was replaced, reboot the stack by entering the `reboot` command at the master node.

- 8 (Optional) Run the `show stacking configuration` command and verify that the configuration is what you want.

**NOTE**

To verify that the new node became operational, enter the `show slot {<slot> {detail} | detail }` command. If the slot shows a *Mismatch* state, the node was replaced with a different type of switch. (See [“Replacing a Node with a Different Switch Type” on page 194.](#))

Replacing a Node with a Different Switch Type

When you replace a node with the different switch type, for example when you replace a Summit X450a-48t with a Summit X450e-48p, you cannot continue to use the same stack configuration. The slot configuration for the replaced node must change to reflect the new switch type.

**NOTE**

If you are replacing a node with the same switch type, you can continue to use the existing stack configuration. For more information, see [“Replacing a Node with the Same Switch Type” on page 192.](#)

To replace a node with a different switch type:

- 1 Use the `show switch`, `show licenses`, and `show stacking configuration` commands to display configuration information for the node to be replaced. Note the following about the switch you are replacing:
 - ExtremeXOS software version
 - Partition on which the switch is booted
 - Effective license level for the stack
 - Slot number
 - Stacking protocol; standard or enhanced?
 - Master-capable feature configuration
 - Node priority
 - Alternate gateway IP address
- 2 Enter the `unconfigure slot <slot>` command to remove the configuration for the node to be replaced.

All configuration parameters (except for the related node's NVRAM-based configurations such as stacking parameters, image to be used, and failsafe account) for the slot are erased.
- 3 Follow the procedure outlined in [“Replacing a Node with the Same Switch Type” on page 192](#).

Merging Two Stacks

You can join or merge two stacks to create one larger stack. However, the maximum number of nodes in an active topology is eight.

The operation performed when two stack segments are joined together depends on the following factors:

- Whether a slot number is duplicated
- Whether both stacks have master nodes
- The states of the nodes in each stack.

If the nodes are configured with stacking enabled, one of the following occurs:

- If two segments are joined, both have operational masters, and at least one of the nodes in one of the stacks duplicates a slot number of a node in the other stack, the join is allowed. The link that has just connected the two stacks shows as *Inhibited*. This prevents accidental stack joins. In this condition, the nodes on the joined segment can still be reconfigured centrally for stacking.
- If two segments are joined, both have operational masters, and all nodes have assigned slot numbers that are unique in both stacks, the dual master situation is automatically resolved.
- If two segments are joined, there are no duplicate slot numbers, one of the segments has a master and a backup node, and the other segment does not have either a master or a backup node, the nodes in this segment are acquired by the master node. These nodes become standby nodes in the stack.

The nodes that are not configured for stacking, do not attempt to join the active topology but nevertheless join the stack.

Any nodes enabled for stacking that are isolated between nodes that are not enabled for stacking attempt to form an isolated active topology.

If one of the nodes that is not configured for stacking is then configured for stacking and restarted, the behavior is as if two active stacks were joined.

Example: Merging Two Stacks

The example in this section demonstrates how to join two stacks. This example assumes two stacks named StackA and StackB. The joined stack assumes the name StackA. Here are displays taken from the original StackA:

```
Slot-1 StackA.8 # show stacking
Stack Topology is a Ring
Active Topology is a Ring
Node MAC Address      Slot  Stack State  Role      Flags
-----
*00:04:96:26:60:DD    1     Active      Master    CA-
00:04:96:26:60:EE    2     Active      Backup    CA-
00:04:96:26:60:FF    3     Active      Standby   CA-
(*) Indicates This Node
Flags: (C) Candidate for this active topology, (A) Active node,
       (O) node may be in Other active topology

Slot-1 StackA.9 # show stacking configuration
Stack MAC in use: 02:04:96:26:60:DD
Node          Slot      Alternate      Alternate
MAC Address   Cfg Cur Prio Mgmt IP / Mask     Gateway      Flags      Lic
-----
*00:04:96:26:60:DD 1    1    Auto 192.168.130.101/24 192.168.130.1  CcEeMm--- Aa
00:04:96:26:60:EE 2    2    Auto 192.168.130.102/24 192.168.130.1  CcEeMm--- Aa
00:04:96:26:60:FF 3    3    Auto 192.168.130.103/24 192.168.130.1  --EeMm--- Aa

* - Indicates this node
Flags: (C) master-Capable in use, (c) master-capable is configured,
       (E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
       (M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
       (N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced
configured,
       (i) Stack MACs configured and in use are not the same or unknown,
       (-) Not in use or not configured
License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
(c) Core, (a) Advanced edge, or (e) Edge configured,
(-) Not in use or not configured

Slot-1 StackA.10 # show stacking stack-ports
Stack Topology is a Ring
Slot Port Select Node MAC Address  Port State  Flags  Speed
-----
*1  1    Native 00:04:96:26:60:DD Operational CB      10G
*1  2    Native 00:04:96:26:60:DD Operational C-     10G
2  1    Native 00:04:96:26:60:EE Operational C-     10G
2  2    Native 00:04:96:26:60:EE Operational C-     10G
3  1    Native 00:04:96:26:60:FF Operational C-     10G
3  2    Native 00:04:96:26:60:FF Operational CB      10G
* - Indicates this node
Flags: (C) Control path is active, (B) Port is Blocked
```

```
Slot-1 StackA.3 # show slot
Slots      Type                Configured          State              Ports
-----
Slot-1     X450e-24p                 X450e-24p         Operational        26
Slot-2     X450a-24t                 X450a-24t         Operational        26
Slot-3     X450a-24tDC              X450a-24tDC       Operational        26
Slot-4
Slot-5
Slot-6
Slot-7
Slot-8
```

Slot-1 StackA.4 #

Here are displays taken from StackB:

```
Slot-1 StackB.3 # show stacking
Stack Topology is a Ring
Active Topology is a Ring
Node MAC Address      Slot Stack State  Role      Flags
-----
00:04:96:26:60:AA    1    Active      Master    CA-
00:04:96:26:60:88    2    Active      Backup    CA-
00:04:96:26:60:99    3    Active      Standby   CA-
(*) Indicates This Node
Flags: (C) Candidate for this active topology, (A) Active node,
       (O) node may be in Other active topology
```

```
Slot-1 StackB.4 # show stacking configuration
Stack MAC in use: 02:04:96:26:60:AA
Node          Slot      Alternate          Alternate
MAC Address   Cfg Cur Prio Mgmt IP / Mask      Gateway          Flags          Lic
-----
*00:04:96:26:60:AA 1    1    Auto 192.168.131.101/24 192.168.131.1    CcEeMm--- Aa
00:04:96:26:60:88 2    2    Auto 192.168.131.102/24 192.168.131.1    CcEeMm--- Aa
00:04:96:26:60:99 3    3    Auto 192.168.131.103/24 192.168.131.1    --EeMm--- Aa
```

* - Indicates this node

Flags: (C) master-Capable in use, (c) master-capable is configured,
(E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
(M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
(N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced
configured,
(i) Stack MACs configured and in use are not the same or unknown,
(-) Not in use or not configured

License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
(c) Core, (a) Advanced edge, or (e) Edge configured,
(-) Not in use or not configured

```
Slot-1 StackB.5 # show stacking stack-ports
Stack Topology is a Ring
Slot Port Select Node MAC Address Port State Flags Speed
-----
 1 1 Native 00:04:96:26:60:AA Operational C- 10G
 1 2 Native 00:04:96:26:60:AA Operational CB 10G
 2 1 Native 00:04:96:26:60:88 Operational CB 10G
 2 2 Native 00:04:96:26:60:88 Operational C- 10G
 3 1 Native 00:04:96:26:60:99 Operational C- 10G
 3 2 Native 00:04:96:26:60:99 Operational C- 10G
* - Indicates this node
Flags: (C) Control path is active, (B) Port is Blocked
```

```
Slot-1 StackB.6 # show slot
Slots Type Configured State Ports
-----
Slot-1 X450a-48t X450a-48t Operational 26
Slot-2 X450a-24x X450a-24x Operational 26
Slot-3 X450a-24xDC X450a-24xDC Operational 26
Slot-4 Empty 0
Slot-5 Empty 0
Slot-6 Empty 0
Slot-7 Empty 0
Slot-8 Empty 0
```

Form the new stack. Assuming both stacks are rings, break one link in each stack as follows:

- For StackA, break the link between node 00:04:96:26:60:FF port 2 and node 00:04:96:26:60:DD port 1.
- For StackB, break the link between node 00:04:96:26:60:99 port 2 and node 00:04:96:26:60:AA port 1.

Then connect the broken links between the two stacks to form a ring as follows:

- Connect node 00:04:96:26:60:FF port 2 to node 00:04:96:26:60:AA port 1.
- Connect node 00:04:96:26:60:99 port 2 to node 00:04:96:26:60:DD port 1.

Since both are active stacks with duplicate slot numbers, the links between the two stacks are in *Inhibited* state. This can be seen using the `show stacking stack-ports` command as shown below in Step 1.

Assume that the master of stack A is to be the master node of the joined stack. Log into the intended master node.

- 1 Verify the details of the new stack using the commands `show stacking`, `show stacking configuration`, and `show stacking stack-ports`.

```
Slot-1 StackA.11 # show stacking
Stack Topology is a Ring
Active Topology is a Daisy-Chain
Node MAC Address Slot Stack State Role Flags
-----
*00:04:96:26:60:DD 1 Active Master CA-
00:04:96:26:60:EE 2 Active Backup CA-
00:04:96:26:60:FF 3 Active Standby CA-
00:04:96:26:60:AA 1 Active Master --O
00:04:96:26:60:88 2 Active Backup --O
00:04:96:26:60:99 3 Active Standby --O
(*) Indicates This Node
```

Flags: (C) Candidate for this active topology, (A) Active node,
(O) node may be in Other active topology

Slot-1 StackA.12 # show stacking configuration

Stack MAC in use: 02:04:96:26:60:DD

Node	Slot	Alternate	Alternate	Flags	Lic
MAC Address	Cfg	Cur	Prio Mgmt IP / Mask	Gateway	
*00:04:96:26:60:DD	1	1	Auto 192.168.130.101/24	192.168.130.1	CcEeMm--- Aa
00:04:96:26:60:EE	2	2	Auto 192.168.130.102/24	192.168.130.1	CcEeMm--- Aa
00:04:96:26:60:FF	3	3	Auto 192.168.130.103/24	192.168.130.1	--EeMm--- Aa
00:04:96:26:60:AA	1	1	Auto 192.168.131.101/24	192.168.131.1	CcEe--i-- --
00:04:96:26:60:88	2	2	Auto 192.168.131.102/24	192.168.131.1	CcEe--i-- --
00:04:96:26:60:99	3	3	Auto 192.168.131.103/24	192.168.131.1	--Ee--i-- --

* - Indicates this node

Flags: (C) master-Capable in use, (c) master-capable is configured,
(E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
(M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
(N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced
configured,
(i) Stack MACs configured and in use are not the same or unknown,
(-) Not in use or not configured

License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
(c) Core, (a) Advanced edge, or (e) Edge configured,
(-) Not in use or not configured

Slot-1 StackA.13 # show stacking stack-ports

Stack Topology is a Ring

Slot	Port	Select	Node	MAC	Address	Port	State	Flags	Speed
*1	1	Native	00:04:96:26:60:DD				Inhibited	--	10G
*1	2	Native	00:04:96:26:60:DD				Operational	C-	10G
2	1	Native	00:04:96:26:60:EE				Operational	C-	10G
2	2	Native	00:04:96:26:60:EE				Operational	C-	10G
3	1	Native	00:04:96:26:60:FF				Operational	C-	10G
3	2	Native	00:04:96:26:60:FF				Inhibited	--	10G
1	1	Native	00:04:96:26:60:AA				Inhibited	--	10G
1	2	Native	00:04:96:26:60:AA				Operational	C-	10G
2	1	Native	00:04:96:26:60:88				Operational	C-	10G
2	2	Native	00:04:96:26:60:88				Operational	C-	10G
3	1	Native	00:04:96:26:60:99				Operational	C-	10G
3	2	Native	00:04:96:26:60:99				Inhibited	--	10G

* - Indicates this node

Flags: (C) Control path is active, (B) Port is Blocked

Slot-1 StackA.14 #

2 Configure the nodes such that they all have unique slot numbers. Because the slot numbers configured for the first three nodes in your stack are consistent with automatic slot assignment, you may perform automatic slot assignment now: `configure stacking slot-number automatic.`

3 Configure the stack MAC address with the command: `configure stacking mac-address.`

4 Configure stacking redundancy so that only slots 1 and 2 are master-capable with the command: `configure stacking redundancy minimal.`

- 5 Configure new alternate IP addresses for nodes from original StackB. Assume that the block of addresses allocated to StackA can be extended, and use the automatic form of the command as follows:

```
configure stacking alternate-ip-address 192.168.130.101/24 192.168.130.1 automatic
```

- 6 For master capable nodes, configure a license restriction to be the minimum of the two original values on all master-capable nodes. Alternatively, you may purchase license upgrades from Extreme if necessary. In this case, use the command:

```
configure stacking license-level edge
```

- 7 Either reboot the entire stack topology using the `reboot stack-topology` command, or individually reboot the three nodes formerly from stack B. The latter requires the following commands:

```
reboot node 00:04:96:26:60:99
```

```
reboot node 00:04:96:26:60:88
```

```
reboot node 00:04:96:26:60:AA
```

The order of reboot should be the Standby nodes first, the Backup node next, and the Master node last. Because none of these nodes is master-capable, there is no temporary dual master situation as a result of these separate node reboots.

- 8 When the rebooted nodes come back up, run the following commands to see the resulting stack. You can verify the joined stack came up as expected, that is, all nodes should have unique slot numbers, a common stack MAC address, and so forth:

```
Slot-1 StackA.11 # show stacking
Stack Topology is a Ring
Active Topology is a Ring
Node MAC Address      Slot  Stack State  Role      Flags
-----
*00:04:96:26:60:DD  1     Active      Master    CA-
00:04:96:26:60:EE  2     Active      Backup    CA-
00:04:96:26:60:FF  3     Active      Standby   CA-
00:04:96:26:60:AA  4     Active      Standby   CA-
00:04:96:26:60:88  5     Active      Standby   CA-
00:04:96:26:60:99  6     Active      Standby   CA-
(*) Indicates This Node
Flags: (C) Candidate for this active topology, (A) Active node,
       (O) node may be in Other active topology
```

```
Slot-1 StackA.12 # show stacking configuration
Stack MAC in use: 02:04:96:26:60:DD
Node          Slot      Alternate      Alternate
MAC Address   Cfg Cur Prio Mgmt IP / Mask   Gateway      Flags      Lic
-----
*00:04:96:26:60:DD 1  1  Auto 192.168.130.101/24 192.168.130.1 CcEeMm--- Aa
00:04:96:26:60:EE 2  2  Auto 192.168.130.102/24 192.168.130.1 CcEeMm--- Aa
00:04:96:26:60:FF 3  3  Auto 192.168.130.103/24 192.168.130.1 --EeMm--- Aa
00:04:96:26:60:AA 4  4  Auto 192.168.130.104/24 192.168.130.1 --EeMm--- Aa
00:04:96:26:60:88 5  5  Auto 192.168.130.105/24 192.168.130.1 --EeMm--- Aa
00:04:96:26:60:99 6  6  Auto 192.168.130.106/24 192.168.130.1 --EeMm--- Aa
```

* - Indicates this node

Flags: (C) master-Capable in use, (c) master-capable is configured,
 (E) Stacking is currently Enabled, (e) Stacking is configured Enabled,
 (M) Stack MAC in use, (m) Stack MACs configured and in use are the same,
 (N) Stack link protocol Enhanced in use, (n) Stack link protocol Enhanced configured,

(i) Stack MACs configured and in use are not the same or unknown,
 (-) Not in use or not configured
 License level restrictions: (C) Core, (A) Advanced edge, or (E) Edge in use,
 (c) Core, (a) Advanced edge, or (e) Edge configured,
 (-) Not in use or not configured

```
Slot-1 StackA.13 # show stacking stack-ports
Stack Topology is a Ring
Slot Port Select Node MAC Address Port State Flags Speed
-----
*1 1 Native 00:04:96:26:60:DD Operational C- 10G
*1 2 Native 00:04:96:26:60:DD Operational C- 10G
2 1 Native 00:04:96:26:60:EE Operational C- 10G
2 2 Native 00:04:96:26:60:EE Operational C- 10G
3 1 Native 00:04:96:26:60:FF Operational C- 10G
3 2 Native 00:04:96:26:60:FF Operational C- 10G
4 1 Native 00:04:96:26:60:AA Operational C- 10G
4 2 Native 00:04:96:26:60:AA Operational CB 10G
5 1 Native 00:04:96:26:60:88 Operational CB 10G
5 2 Native 00:04:96:26:60:88 Operational C- 10G
6 1 Native 00:04:96:26:60:99 Operational C- 10G
6 2 Native 00:04:96:26:60:99 Operational C- 10G
* - Indicates this node
Flags: (C) Control path is active, (B) Port is Blocked
Slot-1 StackA.14 #
```

```
Slot-1 StackA.3 # show slot
Slots Type Configured State Ports
-----
Slot-1 X450e-24p X450e-24p Operational 26
Slot-2 X450a-24t X450a-24t Operational 26
Slot-3 X450a-24tDC X450a-24tDC Operational 26
Slot-4 X450a-48t Operational 50
Slot-5 X450a-24x Operational 26
Slot-6 X450a-24xDC Operational 26
Slot-7 Empty 0
Slot-8 Empty 0
```

9 Configure the new slots in VLANs, IP subnetworks, and so forth as required.

Upgrading ExtremeXOS on a Stack

This section includes the following:

- [“Upgrading the Software on All Active Nodes” on page 201](#)
- [“Upgrading the Software on a Single Node” on page 203](#)
- [“Upgrading the Bootrom” on page 203](#)

Upgrading the Software on All Active Nodes

You can centrally upgrade the software on all active nodes in a stack. To upgrade all nodes in the stack, all nodes must be running an ExtremeXOS release that supports stacking (ExtremeXOS release 12.0 or greater).

Use the command `download image [[<hostname> | <ipaddress>] <filename> {{vr} <vrname>}}] {<partition>}` to download a new ExtremeXOS software release and install it on all nodes on the active topology. If necessary, use the `use image {partition} {primary | secondary}` command to select the image partition (primary or secondary) into which the software was saved. Use the `reboot {[time <mon> <day> <year> <hour> <min> <sec>] | cancel}` command to restart all nodes in the new release. For example:

```
download image [[<hostname> | <ipaddress>] <filename> {{vr} <vrname>}}] {primary |
secondary}
use image {partition} [primary | secondary]
reboot
```

Before you upgrade a stack, make sure that the active image partition is same across all nodes. To determine the active partition selected on all nodes and the ExtremeXOS versions installed in each partition, use the `show slot detail` command. You can install the image only on the alternate image partition and not on the active image partition. To run the upgraded software, you must reboot the stack after installation with the image partition that received the software being selected.

If the active partition is different on some nodes, the action you take depends on what is stored in both partitions:

- If both primary and secondary partitions have the same ExtremeXOS release, you may use the commands

```
use image {primary | secondary} slot <slot-number>
reboot slot <slot-number>
```

to cause a node to use the same active image as the rest of the stack.
- If you are using the primary image on your master node and some other node primary image does not contain the same ExtremeXOS version as your master node's primary image, you may use the command

```
synchronize slot <slotid>
```

to cause the node to contain the same ExtremeXOS versions in both partitions as it is on the master node, and to reboot the node into the primary partition.

**NOTE**

The `synchronize {slot <slotid>}` command is not allowed in certain SummitStack-V configurations when the target slot is occupied by a Summit X450a or X450e series switch. In these cases, you can use the `use image` and `download image` commands to change the images on the node. Use the `save configuration` command to transfer the configuration file. Use the `tftp put` and `tftp get` commands to transfer other files via a remote host (tftp requires alternate IP address configuration on non-master nodes).

**NOTE**

Hitless upgrade is not supported in a stack.

Upgrading the Software on a Single Node

You can upgrade the software on a single active node. Enter the following commands to download an image to a node:

```
download image [[<hostname> | <ipaddress>] <filename> {{vr} <vrname>}}] {<primary |
secondary>} slot <slot number>
use image {partition} [primary | secondary] slot <slotid>
reboot slot <slot number>
```

The slot number is the one in use by the active node that is to be upgraded.

Be sure that you keep the same image versions on all the other nodes as you have on the master node.

Alternatively, if your master node has the same image versions in its partitions that you want installed in the node to be upgraded, you can use the command

```
synchronize slot <slotid>
```

to upgrade both images and select the desired image.



NOTE

The `synchronize {slot <slotid>}` command is not allowed in certain SummitStack-V configurations when the target slot is occupied by a Summit X450a or X450e series switch. In these cases, you can use the `use image` and `download image` commands to change the images on the node. Use the `save configuration` command to transfer the configuration file. Use the `tftp put` and `tftp get` commands to transfer other files via a remote host (tftp requires alternate IP address configuration on non-master nodes).

You can upgrade the image on an active node even if the node shows as *Failed* when using the `show slot` command.

Upgrading the Bootrom

The SummitStack feature does not require a bootrom upgrade. You should not upgrade the bootrom of any node unless there are other reasons to do so. However, the SummitStack feature does allow centralized bootrom upgrade.

You can download and install the bootrom to a specific slot using the slot parameter. The slot parameter is available only on stackable switches in the active stack topology. For information on upgrading the bootrom, see [Appendix B, “Software Upgrade and Boot Options.”](#)

If you do not provide a slot number, the stack attempts to download the bootrom image and install it on all stackable switches in the active topology.

Upgrading SummitStack Option Cards

The following sections describe how to upgrade the SummitStack option cards on Summit family switches:

- [Upgrading a Summit X460 with a SummitStack Option Card on page 204](#)
- [Upgrading a Summit X480 with a VIM2 SummitStack Option Card on page 204](#)
- [Upgrading a Summit X650 with a VIM1-SummitStack256 on page 204](#)
- [Upgrading a Summit X650 with a VIM1-SummitStack512 on page 204](#)

- [Upgrading a Summit X650 Switch with a VIM3-40G4x Option Card on page 206](#)
- [Upgrading a Summit X670V Switch with a VIM4-40G4x Option Card on page 207](#)

Upgrading a Summit X460 with a SummitStack Option Card

To upgrade a Summit X460 in a stack to use a SummitStack or SummitStack V80 option card, do the following:

- 1 Power down the node to be upgraded.
- 2 Replace the option card to be upgraded with the new option card.
- 3 Cable the node as described in the *Summit Family Switches Hardware Installation Guide*.
- 4 Power up the upgraded node.

Upgrading a Summit X480 with a VIM2 SummitStack Option Card

The VIM2 SummitStack option cards include the following:

- VIM2-SummitStack
- VIM2-SummitStack-V80
- VIM2-SummitStack128

To upgrade a Summit X480 in a stack to use the VIM2 SummitStack option card, do the following:

- 1 Power down the nodes to be upgraded.
- 2 Replace the VIMs to be upgraded with the new VIM2 SummitStack option cards.
- 3 Cable each new stack as described in the *Summit Family Switches Hardware Installation Guide*.
- 4 Power up the upgraded nodes.

Upgrading a Summit X650 with a VIM1-SummitStack256

To upgrade a Summit X650 in a stack to use the VIM1-SummitStack256 option card, do the following:

- 1 Upgrade the ExtremeXOS software on all SummitStack nodes to a version that supports VIM1-SummitStack256.
- 2 Power down the nodes to be upgraded.
- 3 Replace the VIMs to be upgraded with the VIM1-SummitStack256 option cards.
- 4 Cable each new Summit switch as described in the *Summit Family Switches Hardware Installation Guide*.
- 5 Power up the upgraded nodes.

Upgrading a Summit X650 with a VIM1-SummitStack512

To upgrade a Summit X650 in a stack to use the VIM1-SummitStack512 option card, do the following:

- 1 Upgrade the ExtremeXOS software on all stack nodes to a version that supports VIM1-SummitStack512.
- 2 Power down the nodes to be upgraded.
- 3 Replace the VIMs to be upgraded with the VIM1-SummitStack512 option cards.
- 4 Reconfigure the stack so that there are no more than 2 Summit X650 switches with VIM1-SummitStack512 option cards in each stack.

5 Cable each new stack as described in the *Summit Family Switches Hardware Installation Guide*.



NOTE

The stack fails if one or both cables are not connected between the VIM1-SummitStack512 option cards.

6 Power up the upgraded nodes.

7 Check that the license level of both Summit X650 switches is as expected. For example:

```
* X650-24t(SS512).2 # show licenses
Enabled License Level:
    Advanced Edge
Enabled Feature Packs:
    None
```

8 Configure the stack license level:

```
* X650-24t(SS512).4 # configure stacking license-level advanced-edge
This command will take effect at the next reboot of the specified node(s).
```

9 Use the configure stacking easy-setup command to set up the stack:

```
* X650-24t(SS512).5 # configure stacking easy-setup
For every node in the 2-node stack, this command will:
- enable stacking
- configure a stack MAC address
- choose and configure a slot number (this node will be assigned to slot 1)
- configure redundancy to minimal (slot 1 will be the master node)
Upon completion, the stack will automatically be rebooted into the new configuration.
Warning: If stacking is already configured, this command will alter that configuration.
```

Warning: There are unsaved configuration changes. You may wish to save them before proceeding.

Do you wish to proceed? (y/N) Yes

Stacking configuration is complete. Rebooting...



NOTE

For the VIM1-SummitStack512 to operate correctly, all 4 physical stack ports must be connected as per the cabling guidelines, and the switch state must be Operational.

```
* Slot-2 Stack.1 # show slot
Slots      Type                Configured          State              Ports
-----
Slot-1     X650-24t(SS512)    Operational        Operational        24
Slot-2     X650-24x(SS512)    Operational        Operational        24
Slot-3                                           Empty              0
Slot-4                                           Empty              0
Slot-5                                           Empty              0
Slot-6                                           Empty              0
Slot-7                                           Empty              0
Slot-8                                           Empty              0
```

```
* Slot-2 Stack.2 # show stacking
Stack Topology is a Ring
Active Topology is a Ring
Node MAC Address      Slot  Stack State  Role      Flags
-----
*00:04:96:35:9d:55  2      Active      Master    CA-
00:04:96:1e:a8:02  1      Active      Backup    CA-
* - Indicates this node
Flags:  (C) Candidate for this active topology, (A) Active Node
        (O) node may be in Other active topology

* Slot-2 Stack.3 # show stacking stack-ports
Stack Topology is a Ring
Slot Port Select Node MAC Address  Port State  Flags Speed
----
*2  1  Native 00:04:96:35:9d:55 Operational C-    128G
*2  2  Native 00:04:96:35:9d:55 Operational C-    128G
   1  2  Native 00:04:96:1e:a8:02 Operational C-    128G
   1  1  Native 00:04:96:1e:a8:02 Operational C-    128G
* - Indicates this node
Flags:  (C) Control path is active, (B) Port is Blocked
```

Upgrading a Summit X650 Switch with a VIM3-40G4x Option Card

To upgrade a Summit X650 in a stack to use the VIM3-40G4x option card, do the following:

- 1 Upgrade the ExtremeXOS software on all stack nodes to a version that supports the VIM3-40G4x option card.
- 2 Power down the nodes to be upgraded.
- 3 Install the VIM3-40G4x option cards.
- 4 Cable the new option card as described in the *Summit Family Switches Hardware Installation Guide*.
- 5 Power up the upgraded nodes.
- 6 To select between the native and alternate stack ports, use the following command:

```
configure stacking-support stack-port [<stack-ports> | all] selection [native {V80 | V160} | V320] | alternate]
```

- 7 To select the configuration of the VIM3-40G4x option card ports, use the following command:

```
configure ports [<port_list> | all] partition [4x10G | 1x40G]
```

For native stack port support, select the 4x10G option for the 80 Gbps rate or the 1x40G option for the 160 Gbps rate.



NOTE

When 40G ports are in 4x10G mode, ports 25, 29, 33, and 37 will not be added to the default VLAN by default.



NOTE

If you change the port configuration on the VIM3-40G4x option card, you must restart the switch to start using the new configuration.

Upgrading a Summit X670V Switch with a VIM4-40G4x Option Card

To upgrade a Summit X670V switch in a stack to use the VIM4-40G4x option card, do the following:

- 1 Upgrade the ExtremeXOS software on all stack nodes to a version that supports the VIM4-40G4x option card.
- 2 Power down the nodes to be upgraded.
- 3 Install the VIM4-40G4x option cards.
- 4 Cable each new option card as described in the *Summit Family Switches Hardware Installation Guide*.
- 5 Power up the upgraded nodes.
- 6 To select between the native and alternate stack ports, use the following command:

```
configure stacking-support stack-port [<stack-ports> | all] selection [native {V80 | V160} | V320] | alternate]
```



NOTE

The native stacking ports on the VIM4-40G4X option card are not supported in this release.

- 7 To select the configuration of the VIM4-40G4x option card ports, use the following command:

```
configure ports [<port_list> | all] partition [4x10G | 1x40G]
```

For native stack port support, select the 4x10G option for the 80 Gbps rate or the 1x40G option for the 160 Gbps rate.



NOTE

If you change the port configuration on the VIM4-40G4x option card, you must restart the switch to start using the new configuration.

Dismantling a Stack

To dismantle a stack and use the Summit switches in stand-alone mode, do the following:

- 1 Determine if the stack is using the SummitStack-V feature by issuing the following command:

```
show stacking stack-ports
```

Examine the *Select* column to determine if any nodes are using alternate (non-native) stack ports.

- 2 For every non-master node in the stack that is using alternate stack ports, log into the node and issue the command:

```
unconfigure stacking-support
```



NOTE

If a node is a member of the active topology, node login can be accomplished from the master node using the `telnet slot <slot-number>` command. Otherwise you will need access to the node's console port, or you can log in through a management network.

**NOTE**

Do not reboot any switches. It is not necessary to unconfigure stacking-support on the master node.

- 3 When the stacking-support option has been removed from all non-master stack nodes, log into the master node and issue the command:

```
unconfigure switch all
```

After this command is entered, the configuration file is deselected, all stacking parameters are reset to factory defaults, and all nodes in the active topology reboot. In effect, this sets all nodes back to the factory default configuration, thus allowing individual redeployment of each switch.

Removing a Node from a Stack

To remove only one switch from the stack:

- 1 Determine if the target node to be removed is using the SummitStack-V feature by issuing the following command:

```
show stacking stack-ports
```

Examine the *Select* column to determine if the target node is using alternate (non-native) stack ports.

- 2 If the target node is using alternate stack ports, do the following:

- a Log into the node and issue the command:

```
unconfigure stacking-support
```

- b Log out of the target node.

**NOTE**

Do not reboot the target node at this time.

- 3 Log into the master node.
- 4 Delete the target node stacking configuration by entering the following command:

```
unconfigure stacking {node-address <node-address> | slot <slot-number>}
```

- 5 Reboot the target node by entering the following command:

```
reboot [node <node-address> | slot <slot-number>]
```

When the node reboots, it detects that the configuration file selected is a stacking configuration file (see [“Understanding Stack Configuration Parameters, Configuration Files, and Port Numbering”](#) on page 147). It de-selects the configuration file and uses the factory defaults.

You may now disconnect the switch from the stack and your networks as needed, and redeploy the switch.

Rebooting a Stack

You can reboot a stack by entering the command `reboot` from the master.

You can:

- Reboot all the nodes in the stack topology
- A specific node
- Reboot all nodes in the active topology
- Move a node to a standby node
- Reboot the stack topology so that every node comes up in standby role

To reboot all nodes in the active topology, enter the following command from a master node login session:

```
reboot
```

To reboot all the nodes in the stack topology, enter:

```
reboot stack-topology
```

To reboot a specific node, enter:

```
reboot node-address <node-address>
```

Or to reboot an active node from another active node, enter:

```
reboot slot <slot-number>
```

Troubleshooting a Stack

Use this section to diagnose and troubleshoot common configuration errors for stacking. The most common errors are:

- The stack did not come up as expected—Use the `show stacking`, `show stacking configuration`, `show stacking-support`, and `show stacking stack-ports` commands to diagnose the problem. There could be incorrect stacking cabling, a configuration error, or powered down nodes. Also check the log using the `show log` command.



NOTE

If two Summit X650 switches are configured as a stack with VIM1-SummitStack512 option cards, the stack will not operate until all cables are connected.

- The switch with the highest priority was not elected manager—nodes might have been powered up at different times. Reboot all nodes in the stack simultaneously.
- A node appears in the stack as expected but does not appear to be operating as configured—Use the `show slot <slot> {detail} | detail }` command to see if there is a license mismatch or an incorrect ExtremeXOS software version. For more information, see [“Managing Licenses on a Stack” on page 184](#).
- A correctly cabled and powered-on node does not appear in the stack—The node might be running an ExtremeXOS version that is earlier than ExtremeXOS 12.0. Upgrade its ExtremeXOS version using the procedure you would use if the node was not part of the stack.

- **The following message appears:** Warning: The Backup stack node is not as powerful or as capable as the Master stack node. This configuration is not recommended for successful use of the failover feature.

This message appears once, about 5 minutes after master node takes control of the stack. To better support the failover feature, follow the guidelines in [“Configuring the Master, Backup, and Standby Roles” on page 175](#).

- **The following message appears:** Notice: There are Standby stack nodes which are more powerful and more capable than the Master and/or Backup stack nodes. This configuration is not recommended for optimal stack performance. We recommend that you reconfigure the stacking master-capability and/or priority parameters to allow the higher performing and more capable nodes to become Master and/or Backup stack nodes.

This message appears once, about 5 minutes after master node takes control of the stack. To optimize stack performance, follow the guidelines in [“Configuring the Master, Backup, and Standby Roles” on page 175](#).

- Either or both ends of a stacking link show that the state is *No Neighbor*. This can happen when the port at either end is configured incorrectly. Some configuration errors can produce the *No Neighbor* state at one end and the *Link Down* state at the other end. Check the configuration at each port and correct as necessary.
- If the `show stacking` command displays the node status as *Disabled*, you need to enable stacking on that node with the `enable stacking` command. You can enable stacking on the node from the master node, and you can reboot the disabled node from the master node to activate the slot number configuration.
- If the `show stacking` command shows the stack state for a slot as *Failed*, check the following:
 - Does the `show stacking stack-ports` command show a port state as *Inhibited*? If so, the problem might be a duplicate slot number. If more than one node is using the same slot number, change the slot number on one of the affected nodes to a unique slot number.
 - Is the affected node isolated by other nodes for which the stack state is listed as *Disabled*? If so, you need to enable stacking on the disabled nodes.
 - Enter the `show slot detail` command. If the command displays *License Mismatch*, either upgrade the node license, or configure a license level restriction so that all master-capable nodes are at the same effective license level.
 - Enter the `show slot detail` command. If the command displays *Incompatible EXOS Version*, log into the master node and use the `synchronize slot` command to update the failed node.
- If the `show stacking` command shows the stack state for a slot as *Active* and the “O” flag is set, check to see if the node is isolated from other stack nodes by a failed node.

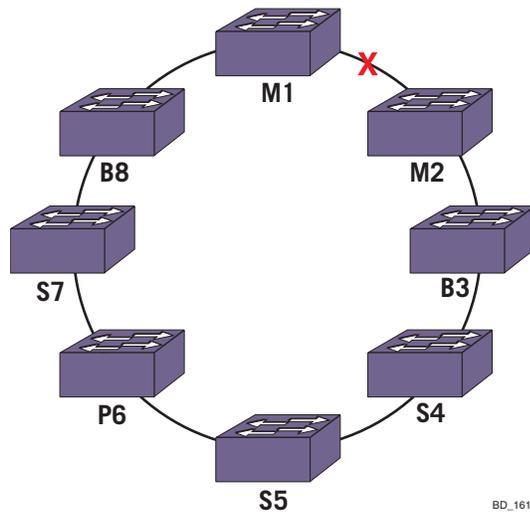
This remainder of this section describes the following troubleshooting topics:

- [Managing a Dual Master Situation on page 210](#)
- [Setting Traps for Stacking on page 213](#)
- [Rescuing a Stack That Has No Master-Capable Node on page 214](#)
- [Connecting to a Stack with No Master on page 213](#)

Managing a Dual Master Situation

If a daisy chain is broken, or if a ring is broken in two places, it is possible to form two separate Active Topologies. This results in a dual master situation.

Figure 8: Example of a Split Stack That Results in a Dual Master Situation



P6	Node 6 is powered off
M	Master node
B	Backup node
S	Standby node
X	Indicates the broken link

For example, in Figure 8, a link is broken while a node in the ring was powered off. The link that is now broken formerly connected the original master (M1) and backup (M2) nodes of a single active topology.

All nodes in the stack except the powered off node are in the active topology and all nodes are configured to be master-capable. Nodes 1, 7 and 8 form an active topology and nodes 2, 3, 4, and 5 form another active topology. Node M2 immediately transitions from backup to master node role. Nodes B8 and B3 are elected in their respective active topologies as backup nodes.

If the backup node is on one stack and the master node is on the other, the backup node becomes a master node because the situation is similar to that of master failure. Because both the stacks are configured to operate as a single stack, there is confusion in your networks. For example, all of the switch's configured IP addresses appear to be duplicated. The management IP address also appears to be duplicated since that address applies to the entire original stack.

To help mitigate the dual master problem, you can configure the *master-capability* so as to prevent some nodes in the stack from operating in backup or master node roles. In addition, you can force all nodes in the (broken) stack topology to restart and come up as not master-capable for the life of that restart. The `save configuration {primary | secondary | <existing-config> | <new-config>}` command saves the configuration on all nodes in the active topology.

Standby nodes that exist in a severed stack segment that does not contain either the original master or backup node do not attempt to become the master node. Instead, these nodes reboot. After rebooting, however, a master election process occurs among the nodes on this broken segment, resulting in a dual master situation.

Dual master conditions are also possible when two non-adjacent nodes in a ring or a single (middle) node in a daisy chain reboot. For a period of time, a rebooting node does not advertise itself to its

neighbors, resulting in temporary stacking link failures. This could cause node isolation, and the nodes that are isolated perform as a severed stack segment depending on the circumstances of the severance:

- if the backup node is on the broken portion, it becomes a (dual) master;
- if the backup node is on the same portion as the master, all nodes on the (other) broken portion reboot.

When the rebooting nodes have sufficiently recovered, or when a severed stack is rejoined, the dual master condition is resolved, resulting in the reboot of one of the master nodes. All standby and backup nodes that had been acquired by the losing master node also reboot.

You can avoid a dual master possibility during configuration by:

- Configuring the stack in a ring topology.
- Avoiding too many master-capable nodes when configuring larger stacks.
- Placing the master-capable nodes that provide stack redundancy such that stacking link severances are unlikely.

Eliminating a Dual Master Situation Manually

To eliminate the dual master situation, you need to know all the nodes that are supposed to be in the stack. You might lose the management connectivity to the master node because the other master node duplicates the stack's primary management IP address and stack MAC address.



NOTE

The following procedure is necessary only if you cannot reconnect the severed link in a timely manner. If you can reconnect, the dual master condition resolves itself. The formerly broken portion of the stack reboots and the nodes come up as standby nodes.

- 1 If you lose the management connectivity, log into the master node using its alternate management IP address.
- 2 Use the `show stacking` command to determine the nodes that have been lost from the stack. You should already know all the nodes that are expected to be part of the stack.
- 3 Log into any node in the severed segment you wish to deactivate, either through its console port or through the management interface using the alternate management IP address. Issue `show stacking` to find whether the broken segment has indeed elected a new master node.
- 4 Reboot the broken segment forcing all nodes in the segment to come up as standby nodes using the `reboot stack-topology as-standby` command.

If you have unsaved configuration changes, take care when selecting the stack segment to be rebooted.

You should reboot the segment that has the smaller System UpTime.

If you know the node that was master of the unbroken stack, you can reboot the stack segment that does not contain this master node. Otherwise, determine the System UpTime shown by each master node.

If the System UpTimes of both masters are the same, you can reboot either segment without loss of unsaved configuration changes. If the System UpTimes of both masters differ, you must reboot the segment with the smaller System UpTime.

Automatic Resolution of the Dual Master Situation

When two stack segments are connected together and no slot number is duplicated on either segment, it is assumed that this is a severed stack rejoin. It is possible that each stack segment has its own master. Resolution of the dual master situation should generally be in favor of the original stack segment's master node. This is because the original stack segment may still retain the unsaved configuration. If the severed segment was restarted before electing a new master node, the unsaved configuration is lost on that segment.

The master election is done using the System UpTime. The master election process collects the System UpTime information of the nodes. If a failover occurs, the System UpTime is inherited by the new master node, and the new master node continues to increase it as time passes. Thus the System UpTime is the time since a master was first elected on a segment. When the stack is broken and both master and backup nodes are on the same segment, the severed segment always has the smaller System UpTime.

If a stack severance results in the master and backup nodes being on different segments, both have the same System UpTime. In this case, the master is elected using the normal node role election method.

Setting Traps for Stacking

The stack generates traps that provide status information about the switches in the stack and also stacking port status. Traps generated by the stack include:

- extremeStackMemberStatusChanged
- extremeStackMemberSlotId—Indicates the slot ID
- extremeStackMemberOperStatus—Indicates the slot state of the switch

The stack generates this trap when an overheat condition is detected on an active node:

- extremeStackMemberOverheat

This trap is generated when the node reaches a steady state. Whenever a member is added or deleted from the stack, the change is indicated through this trap:

- extremeStackingPortStatusChanged
 - IfIndex—Interface Index of the port
 - extremeStackingPortRemoteMac—MAC Address of the remote switch attached to this port
 - extremeStackingPortLinkSpeed—Indicates 10/100/1000 Mbps
 - extremeStackingPortLinkStatus—Status of the link

The trap is generated whenever the status of a stacking port changes.

Connecting to a Stack with No Master

If an entire stack has no master node because the stack has been rebooted in standby only mode, you can log in to a node by using the failsafe account.

If a new node has been added to the stack since the stack failsafe account was configured, logging in to that node requires knowledge of the failsafe account information that is already configured into that node's NVRAM.

If you do not know the failsafe account and you still want to log in to the stack, you have to:

- Join the stack to another segment that has a master node to which the you have access
- Manually restart the stack to clear the *as-standby* condition if the `reboot stack-topology as-standby` command was previously used
- Use the procedure described in [“Rescuing a Stack That Has No Master-Capable Node” on page 214](#)

Rescuing a Stack That Has No Master-Capable Node



NOTE

If a node becomes unbootable, refer to the Troubleshooting appendix for information.

You can have a stack with nodes that are all configured with the master-capability set to off.

For example, if a stack was operating with no redundancy (for example, with one master-capable node) and the master node failed, all other nodes in the stack restart as standby nodes and there is no master node.

Another example is the case where you dismantle a stack before using the `unconfigure stacking` or `unconfigure switch all` command. In this case, individual Summit switches are configured for stacking, not master-capable, and are isolated from a stack master.

In this situation, the only security information available is the failsafe account. If you know the failsafe user name and password, you can log into any node and reconfigure master-capability or redundancy. However, if you do not know the failsafe account information, there is another way you can change the configuration.

At the login prompt, enter the following special login ID exactly as displayed here (all uppercase letters) and press Enter:

```
REBOOT AS MASTER-CAPABLE
```

The following message appears:

```
Node reboot initiated with master-capability turned on.
```

This node then sets an internal indicator that is preserved across the reboot. While restarting, the node notices and resets this indicator, ignores the node master-capability configuration, and becomes a master node.

Since the `save configuration {primary | secondary | <existing-config> | <new-config>}` command saves the configuration file to all nodes, the node that just rebooted as master-capable should have access to the security information that was configured for the stack. If a RADIUS server is needed, the selected node requires a network connection for authentication.

The special login ID described above is available only if all the following conditions are met:

- The node supports the SummitStack feature.
- Stacking mode is active on the node.
- All nodes in the active topology have master-capability turned off.
- There is no master node in the active topology.

If the above conditions are met, five minutes after starting the node and every five minutes after that, the following message appears on the console:

```
Warning: the stack has no Master node and all active nodes are operating with
master-capability turned off. If you wish to reconfigure, you may log in
using the failsafe account. Alternatively, you may use the special login
REBOOT AS MASTER-CAPABLE
with no password to force a reboot of a node with master-capability
temporarily turned on.
```

Using the special login ID does not alter the master-capability configuration permanently. If you restart a node that has been restarted with the special login ID, that node restarts using its configured master-capability; unless you again use the special login ID to restart.

The procedure described here is generally not needed if another node that is master-capable is expected to rejoin the stack. If this procedure is used, it is possible that the new master duplicates the master that is expected to rejoin later.

When a node has been rebooted using the special login ID, it becomes a Master. While the node is a master, the special login ID is not recognized, even though the entire stack is still configured as not master-capable. To get the special login ID to be recognized, the node must be rebooted again.

If a node has been intentionally separated from the stack without first being unconfigured, its security configuration might be unusable. In this case, perform the following steps:

- Connect to the node's console port.
- Reboot the node using the special REBOOT AS MASTER-CAPABLE login described above.
- During the reboot, enter the bootrom program by waiting until you see the message *Starting Default Bootloader ...* and then pressing and holding the space bar until the bootrom prompt appears.
- Force the switch to boot up with a default configuration by entering the following commands at the bootrom prompt:

```
config none
boot
```

The switch boots up in stacking mode operating as a master-capable switch. You can then log in using the default admin account with no password.



NOTE

The special login ID does not function on stacks that have nodes configured to be master-capable, even when the `reboot stack-topology as-standby` command is issued.

Stacking Link Failure

A stacking link is said to be failed when one of the following happens:

- The stacking link is physically disconnected.
- The neighbor on a link stops transmitting topology information.
- The link goes down while a node restarts or when it is powered off.

Based on the stacking topology, the stack behavior changes.

Ring Topology . All traffic paths that were directed through the failed link are redirected. All nodes converge on the new (daisy chain) topology that results from the link break. The Topology Protocol that determines the stack topology immediately informs other nodes that a link has failed. Each node starts the process of redirecting traffic paths.

Daisy chain . A stacking link failure means a severed stack. The Topology Protocol reports the loss of all nodes in the severed portion. Depending on master capability configuration and the original location of the backup node, the severed portion may or may not elect a new master node. If it does, the dual master condition may be in effect.

The `show slot {<slot> {detail} | detail }` command displays the slots that contain active nodes that are in the severed portion as Empty.

FAQs on the SummitStack Feature

- How can I find the slot number of the master slot in a stack?
To find the slot number of the master slot, log in to any stack node and run the command `show stacking`.
- How would I know whether there is a dual master situation in a stack?
A main symptom is loss of IP connectivity. Run the `show stacking` command to see whether all expected nodes are still in the stack.
- How would I find the current topology of the stack?
Run `show stacking` command.
- Can I enable EAPS on stacking?
Yes. You can enable the EAPS on a stack. EAPS operates in your networks even if an EAPS path crosses through the stacking links. EAPS is not used as a redundancy protocol for the stacking ring.
- Why should I configure an Alternate IP address?
To enable login to an individual node using the management port of the node and to be able to configure a node individually. It is most beneficial in manually resolving a dual master situation since connectivity using the alternate IP address is not affected by the dual master situation.

5

CHAPTER

Configuring Slots and Ports on a Switch

This chapter describes the following sections:

- [Overview on page 217](#)
- [Configuring Slots on Modular Switches on page 217](#)
- [Configuring Ports on a Switch on page 219](#)
- [Using the Precision Time Protocol on page 267](#)
- [Jumbo Frames on page 280](#)
- [Link Aggregation on the Switch on page 283](#)
- [MLAG on page 299](#)
- [Mirroring on page 308](#)
- [Remote Mirroring on page 313](#)
- [Extreme Discovery Protocol on page 319](#)
- [Software-Controlled Redundant Port and Smart Redundancy on page 320](#)
- [Configuring Automatic Failover for Combination Ports on page 323](#)
- [Displaying Port Information on page 324](#)

Overview

This chapter describes the processes for enabling, disabling and configuring individual and multiple ports and displaying port statistics.

Configuring Slots on Modular Switches

This section describes configuring slots on modular switches, which are the BlackDiamond X8 switches, BlackDiamond 8800 series switches, and SummitStack.

In a SummitStack, a slot number is assigned to a node through configuration and stored in the node's NVRAM. It takes effect only when the node restarts. In the following descriptions, the phrase *inserted into a slot* in a SummitStack means that the node has become active, and because of its configured slot value it appears to be present in a slot when the `show slot` command is run. The relationship of a node

and a slot does not change if the SummitStack is rewired. The term *module* refers to a Summit family switch that may be present in the stack as an active node.

If a slot has not been configured for a particular type of module, then any type of module is accepted in that slot, and a default port and VLAN configuration is automatically generated.

After any port on the module has been configured (for example, a VLAN association, a VLAN tag configuration, or port parameters), all the port information and the module type for that slot must be saved to non-volatile storage. Otherwise, if the modular switch or SummitStack is rebooted or the module is removed from the slot, the port, VLAN, and module configuration information is not saved.

**NOTE**

For information on saving the configuration, see [Appendix B, “Software Upgrade and Boot Options.”](#)

You configure the modular switch or a SummitStack with the type of input/output (I/O) module that is installed in each slot. To do this, use the following command:

```
configure slot <slot> module <module_type>
```

You can also preconfigure the slot before inserting the module. This allows you to begin configuring the module and ports before installing the module in the chassis or activating the related node in the SummitStack.

If a slot is configured for one type of module, and a different type of module is inserted, the inserted module is put into a mismatch state and is not brought online. To use the new module type in a slot, the slot configuration must be cleared or configured for the new module type. To clear the slot of a previously assigned module type, use the following command:

```
clear slot <slot>
```

All configuration information related to the slot and the ports on the module is erased. If a module is present when you issue this command, the module is reset to default settings.

To display information about a particular slot, use the following command:

```
show slot {<slot>} {detail}
```

Information displayed includes:

- Module type, part number and serial number
- Current state (power down, operational, diagnostic, mismatch)
- Port information

If no slot is specified, information for all slots is displayed.

All slots on the modular switches are enabled by default. To disable a slot, use the following CLI command:

```
disable slot
```

To re-enable slot, use the following CLI command:

```
enable slot
```

On the BlackDiamond X8 switch, the command to disable a fabric slot is:

```
disable slot <FM-1 | FM-2 | FM-3 | FM-4> {offline}
```

When a fabric slot is disabled, it is powered off and the bandwidth it provides is unavailable. Disabling an active fabric slot reroutes the switch fabric traffic before powering off the inserted FM blade. Thus, if there are four active fabric modules when one is disabled, there should be no traffic loss.

On the BlackDiamond X8 switch, the command to enable a fabric slot is:

```
enable slot <FM-1 | FM-2 | FM-3 | FM-4>
```

You can configure the number of times that a slot can be restarted on a failure before it is shut down. To set the restart-limit, use the following command:

```
configure slot <slot-number> restart-limit <num_restarts>
```

Configuring Ports on a Switch



NOTE

A port can belong to multiple virtual routers (VRs). See [Chapter 16, “Virtual Routers,”](#) for more information on VRs.

This section describes the following topics:

- [Port Numbering on page 219](#)
- [Enabling and Disabling Switch Ports on page 220](#)
- [Configuring Switch Port Speed and Duplex Setting on page 221](#)
- [Flow Control on page 224](#)
- [IPFIX on page 231](#)
- [WAN PHY OAM on page 235](#)
- [Configuring Switching Mode—Cut-through Switching on page 237](#)
- [SyncE on page 238](#)
- [TDM PWE and TDM Timing on page 241](#)
- [Overview of PTP on page 268](#)
- [DWDM Optics Support on page 279](#)

Port Numbering

ExtremeXOS runs on both stand-alone and modular switches, and the port numbering scheme is slightly different on each. There are also special considerations for mobile backhaul routers. This section describes the following topics:

- [Stand-alone Switch Numerical Ranges on page 220](#)
- [Modular Switch and SummitStack Numerical Ranges on page 220](#)
- [Mobile Backhaul Routers on page 220](#)

Stand-alone Switch Numerical Ranges

On a stand-alone switch, such as a Summit family switch, the port number is simply noted by the physical port number, as shown below:

5

Separate the port numbers by a dash to enter a range of contiguous numbers, and separate the numbers by a comma to enter a range of noncontiguous numbers:

- `x-y`—Specifies a contiguous series of ports on a stand-alone switch
- `x,y`—Specifies a noncontiguous series of ports on a stand-alone switch
- `x-y,a,d`—Specifies a contiguous series of ports and a series of noncontiguous ports on a stand-alone switch

Modular Switch and SummitStack Numerical Ranges

On a modular switch and SummitStack, the port number is a combination of the slot number and the port number. The nomenclature for the port number is as follows:

`slot:port`

For example, if an I/O module that has a total of four ports is installed in slot 2 of the chassis, the following ports are valid:

- 2:1
- 2:2
- 2:3
- 2:4

You can also use wildcard combinations (*) to specify multiple modular slot and port combinations. The following wildcard combinations are allowed:

- `slot:*`—Specifies all ports on a particular I/O module or stack node
- `slot:x-slot:y`—Specifies a contiguous series of ports on multiple I/O modules or stack nodes
- `slot:x-y`—Specifies a contiguous series of ports on a particular I/O module or stack node
- `slota:x-slotb:y`—Specifies a contiguous series of ports that begin on one I/O module or stack node and end on another I/O module or stack node

Mobile Backhaul Routers

Mobile backhaul routers include the E4G-200 and E4G-400. Commands operating on a `<port_list>` for mobile backhaul routers all use the keyword “`tdm`.” When the `tdm` keyword is present, the `<port_list>` is expanded to include only time division multiplexing (TDM) ports, omitting any Ethernet ports occurring within the `<port_list>` range. Existing CLI commands without the `tdm` keyword continue to work as usual without any change, and these commands omit any TDM ports that may lie within the `<port_list>` range.

Enabling and Disabling Switch Ports

By default, all ports are enabled. To enable or disable one or more ports on a switch, use the following commands:

```
enable port [<port_list> | all]
```

```
disable port [<port_list> | all]
```

For example, to disable slot 7, ports 3, 5, and 12 through 15 on a modular switch or SummitStack, use the following command:

```
disable port 7:3,7:5,7:12-7:15
```

You have the flexibility to receive or not to receive SNMP trap messages when a port transitions between up and down. To receive these SNMP trap messages, use the following command:

```
enable snmp traps port-up-down ports [<port_list> | all]
```

To stop receiving these messages, use the following command:

```
disable snmp traps port-up-down ports [<port_list> | all]
```

Refer to “[Displaying Port Information](#)” for information on displaying link status.



NOTE

You can choose to boot the BlackDiamond 12800 series switches with the ports disabled. This information is saved in NVRAM and is not saved in the “.cfg” configuration files. Use the commands `configure switch ports initial-mode disabled` to disable and `configure switch ports initial-mode enabled` to enable, and `show switch` to display the configuration. You cannot disable the stacking ports of a Summit family switch (whether or not it is included in a SummitStack).

Configuring Switch Port Speed and Duplex Setting



NOTE

Refer to “[Displaying Port Information](#)” for information on displaying port speed, duplex, autonegotiation, and flow control settings.

ExtremeXOS supports the following port types:

- 10 Gbps ports
- 40 Gbps ports
- 10/100/1000 Mbps copper ports
- 10/100/1000 SFPs
- 10/100/1000 Mbps copper ports with Power over Ethernet (PoE)—only on the G48Tc, G48Te2, and 8900-G48T-x1 with PoE daughter card modules installed in the BlackDiamond 8800 series switch, and the Summit X250e-24p, X250e-48p, X440-24p, X450e-24p, X450e-48p, X460-24p, and X460-48p switches
- 1 Gbps small form factor pluggable (SFP) fiber ports
- 100 FX SFPs, which must have their speed configured to 100 Mbps
- 100/1000 FX/LX SFP SFP ports—only on BlackDiamond 8800 series switches, BlackDiamond 12800 series switches, SummitStack, and the Summit family switches
- Wide area network (WAN) PHY port—only on the Summit X450a and X480 series switches
- 10/100 Mbps copper ports with Power over Ethernet (PoE) ports for Summit X250e series switches
- 10Gbps stacking ports (Summit family switches only)

- 10 Gbps small Form Factor pluggable+ (SFP+) fiber ports. These should be configured to 10Gbps auto off if an SFP+ optic is inserted; they should be configured to 1G auto on (or auto off) if 1G SFP optic is inserted. Note that Summit X650-24x, ports 23 and 24 can only support SFP+ optics.

**NOTE**

Stacking ports always use the same type of connector and copper PHY which are built in to the Summit family switches. You cannot configure stacking port parameters such as port speed, duplex, and link fault signal. You also cannot configure data port features such as VLANs and link aggregation. Stacking links provide the same type of switch fabric that is provided in a BlackDiamond 8800 series switch or BlackDiamond X8 series switch.

Autonegotiation determines the port speed and duplex setting for each port (except 10 and 40 Gbps ports). You can manually configure the duplex setting and the speed of 10/100/1000 Mbps ports.

The 10/100/1000 Mbps ports can connect to either 10BASE-T, 100BASE-T, or 1000BASE-T networks. By default, the ports autonegotiate port speed. You can also configure each port for a particular speed (either 10 Mbps or 100 Mbps).

**NOTE**

With autonegotiation turned off, you cannot set the speed to 1000 Mbps.

In general, SFP gigabit Ethernet ports are statically set to 1 Gbps, and their speed cannot be modified. However, there are two SFPs supported by Extreme that can have a configured speed:

- 100 FX SFPs, which must have their speed configured to 100 Mbps
- 100FX/1000LX SFPs, which can be configured at either speed (available only on the BlackDiamond 8800 series switches, the BlackDiamond 12800 series switches, and the Summit family switches)

The 10 Gbps ports always run at full duplex and 10 Gbps.

The 40 Gbps ports always run at full duplex and 40 Gbps.

ExtremeXOS allows you to specify the medium as copper or fiber when configuring Summit switches with combination ports. If the medium is not specified for combination ports then the configuration is applied to the current primary medium. The current primary medium is displayed in the Media Primary column of the `show ports configuration` command output.

To configure port speed and duplex setting, use the following command:

```
configure ports <port_list> {medium [copper | fiber]} auto off speed <speed> duplex
[half | full]
```

To configure the system to autonegotiate, use the following command:

```
configure ports <port_list> {medium [copper|fiber]} auto on [{speed <speed>} {duplex
[half | full]}] | [{duplex [half | full]} {speed <speed>}]
```

**NOTE**

The keyword `medium` is used to select the configuration medium for combination ports. If `port_list` contains any non-combination ports, the command is rejected.

**NOTE**

When upgrading a switch running ExtremeXOS 12.3 or earlier software to ExtremeXOS 12.4 or later, saved configurations from combo ports (copper or fiber) are applied only to combo ports fiber medium. When downgrading from ExtremeXOS 12.4 or later to ExtremeXOS 12.3 or earlier, saved configurations from combo ports (copper or fiber) are silently ignored. Therefore, you need to reconfigure combo ports during such an upgrade or downgrade.

ExtremeXOS does not support turning off autonegotiation on the management port.

Table 25 lists the support for autonegotiation, speed, and duplex setting for the various types of ports.

Table 25: Support for Autonegotiation on Various Ports

Port	Autonegotiation	Speed	Duplex
10 Gbps	Off	10000 Mbps	Full duplex
1 Gbps fiber SFP	On (default) Off	1000 Mbps	Full duplex
100 FX SFP	On (default) Off	100 Mbps	Full duplex
100/1000 Mbps FX/LX SFP SFP	On (default) Off	100 Mbps 1000 Mbps	Full duplex
10/100/1000 Mbps	On (default) Off	10 Mbps 100 Mbps	Full/half duplex Full/half duplex
10/100 Mbps	On (default) Off	10 Mbps 100 Mbps	Full/half duplex Full/half duplex
10 Gbps SFP+	Off	10000 Mbps	Full duplex

Flow control on Gigabit Ethernet ports is enabled or disabled as part of autonegotiation (see IEEE 802.3x). If autonegotiation is set to Off on the ports, flow control is disabled. When autonegotiation is turned On, flow control is enabled.

With Extreme Networks devices, the 1 Gbps ports and the 10 Gbps ports implement flow control as follows:

- 1 Gbps ports
 - Autonegotiation enabled
 - Advertise support for pause frames
 - Respond to pause frames
 - Do not transmit pause frames
 - Autonegotiation disabled
 - Do not advertise support for pause frames
 - Do not respond to pause frames
 - Do not transmit pause frames
- 10 Gbps ports for the Summit X450a, X450e, X460, X480, and X650 series switches, SummitStack, and on modules for the BlackDiamond X8 series switches and the BlackDiamond 8800 series switch:
 - Autonegotiation always disabled
 - Do not advertise support for pause frames
 - Respond to pause frames
 - Do not transmit pause frames

Partitioning 40G Ports

The 40G ports on BlackDiamond X8 switches, BlackDiamond 8900-40G6X-xm modules and Summit X650 and X670 switches can be partitioned into 4x10G or 1x40G modes.

To partition the ports, use the following command:

```
configure ports [<port_list> | all] partition [4x10G | 1x40G]
```

After you make a configuration change, you must do one of the following to apply the change:

- For BlackDiamond X8 series switches and BlackDiamond 8900-40G6X-xm modules, you can disable and then enable the affected slot, which applies the change without affecting other modules
- For BlackDiamond X8 series switches, BlackDiamond 8900-40G6X-xm modules and Summit X650 and X670 switches you can reboot the switch



NOTE

Because of the nature of these ports at the physical layer level, the 10G side may show a remote or local linkup.

A configuration change is not applied until the affected slot is disabled and enabled or the switch is rebooted.

Flow Control

This section describes the following topics:

- [IEEE 802.3x Flow Control—Summit Family Switches, BlackDiamond X8 Series Switches and BlackDiamond 8800 Series Switches Only on page 224](#)
- [IEEE 802.1Qbb Priority Flow Control—BlackDiamond X8 Series Switches, BlackDiamond 8900-10G24X-c and 8900-40G6X-xm Modules and Summit X460, X650, and X670 Switches on page 225](#)

IEEE 802.3x Flow Control—Summit Family Switches, BlackDiamond X8 Series Switches and BlackDiamond 8800 Series Switches Only

As mentioned above, with autonegotiation enabled, Summit family switches, BlackDiamond X8 switches, and BlackDiamond 8800 series switches advertise the ability to support pause frames. This includes receiving, reacting to (stopping transmission), and transmitting pause frames. However, the switch does not actually transmit pause frames unless it is configured to do so, as described below.

IEEE 802.3x flow control provides the ability to configure different modes in the default behaviors. Ports can be configured to transmit pause frames when congestion is detected, and the behavior of reacting to received pause frames can be disabled.

TX. You can configure ports to transmit link-layer pause frames upon detecting congestion. The goal of IEEE 802.3x is to backpressure the ultimate traffic source to eliminate or significantly reduce the amount of traffic loss through the network. This is also called lossless switching mode.

The following limitations apply to the TX flow control feature:

- Flow control is applied on an ingress port basis which means that a single stream ingressing a port and destined to a congested port can stop the transmission of other data streams ingressing the same port which are destined to other ports.

- High volume packets destined to the CPU can cause flow control to trigger. This includes protocol packets such as, EDP, EAPS, VRRP, and OSPF.
- When flow control is applied to the fabric ports, there can be a performance limitation. For example, a single 1G port being congested could backpressure a high-speed fabric port and reduce its effective throughput significantly.

To configure a port to allow the transmission of IEEE 802.3x pause frames, use the following command:

```
enable flow-control tx-pause ports
```



NOTE

To enable TX flow-control, RX flow-control must first be enabled. If you attempt to enable TX flow-control with RX flow-control disabled, an error message is displayed.

To configure a port to return to the default behavior of not transmitting pause frames, use the following command:

```
disable flow-control tx-pause ports
```

RX. You can configure the switch to disable the default behavior of responding to received pause frames. Disabling rx-pause processing avoids dropping packets in the switch and allows for better overall network performance in some scenarios where protocols such as TCP handle the retransmission of dropped packets by the remote partner.

To configure a port to disable the processing of IEEE 802.3x pause frames, use the following command:

```
disable flow-control rx-pause ports
```



NOTE

To disable RX flow-control, TX flow-control must first be disabled. If you attempt to disable RX flow-control with TX flow-control enabled, an error message is displayed.

To configure a port to return to the default behavior of enabling the processing of pause frames, use the following command:

```
enable flow-control rx-pause ports
```

IEEE 802.1Qbb Priority Flow Control—BlackDiamond X8 Series Switches, BlackDiamond 8900-10G24X-c and 8900-40G6X-xm Modules and Summit X460, X650, and X670 Switches

Priority flow control (PFC) as defined in the IEEE 802.1Qbb standard is an extension of IEEE 802.3x flow control which is discussed above. When buffer congestion is detected, IEEE 802.3x flow control allows the communicating device to pause all traffic on the port whereas IEEE 802.1Qbb allows the device to pause just a portion of the traffic while allowing other traffic on the same port to continue.

For PFC, when an ingress port detects congestion, it generates a MAC control packet to the connected partner with an indication of which traffic priority to pause and an associated time for the pause to remain in effect. The recipient of the PFC packet then stops transmission on the priority indicated in the control packet and starts a timer indicating when traffic can resume.

Traffic can resume in two ways:

- On the transmitting side, when the timer expires, traffic on that priority can resume.

- On the receiving side, once congestion is relieved, another PFC packet is generated to un-pause the priority so that traffic can resume.

Limitations. The following limitations are associated with this feature:

- In this release, PFC must be explicitly configured by the user.
- In order to support the signaling of congestion across the fabric, an enhanced fabric mode is required. This enhanced mode is not available on some older models of Summits and BlackDiamond 8000 series modules (see the following supported platforms section). Also, this enhanced mode reduces the effective bandwidth on the fabric by a small amount (less than 5%). The BlackDiamond 8900-10G24X-c becomes slightly more blocking and the BlackDiamond 8900-10G8X-xl card is no longer non-blocking when this enhanced mode is configured.
- The fabric flow control packets take up some small amount of bandwidth on the fabric ports.
- On Summit X670 and X670V switches, the PFC feature does not support fabric flow control messages on alternate stack ports or SummitStack-V80 native stack ports.

Supported Platforms. PFC is currently supported only on 10G ports and on specific models of the following newer platforms indicated by the part number:

- BlackDiamond X8 series switches
- BlackDiamond 8900-10G24X-c modules (manufacturing number 800397-00)
- BlackDiamond 8900-40G6X-xm modules, 40G ports and 10G ports when in 4x10 partition mode
- Summit X460 switches, 10G ports
- Summit X650-24t switches (manufacturing number 800394-00)
- Summit X650-24x switches (manufacturing number 800395-00)
- Summit X650 VIM-10G8X (manufacturing number 800396-00)
- Summit X670 switches, 10G ports
- Summit X670V switches, 10G and 40G ports

To verify that your switch or module supports PFC, use the `show version` command. If you attempt to enable PFC on unsupported ports, an error message is displayed. (See [Abnormal Configuration Examples](#) below.)

Setting the Priorities. Priority is established for reception of PFC packets with a QoS profile value on the ExtremeXOS switch and for transmission with a priority value added to the PFC packet.

- QoS profile—Ingress traffic is associated with a QoS profile for assignment to one of eight hardware queues in the system that define how the traffic flows with respect to bandwidth, priority, and other parameters. By default, there are two QoS profiles (QP1 and QP8) defined in these supported platforms and PFC works with this default. To segregate the ingress traffic with more granularity, you will want to define other QoS profiles. The traffic that will be paused on reception of the PFC packet is associated with the hardware queue of the QoS profile that you specify.

The QoS profile is also used to configure the fabric ports.

- Priority—When the hardware transmits a PFC packet, it uses the priority bits in the VLAN header on the ingress packet to determine the priority to pause, if the ingress packet is tagged. You can specify this transmit priority independently from the QoS profile to associate it with the reception of a PFC packet thus giving flexibility in the configuration of the network. For untagged ingress packets, the hardware queue determines the priority in the transmitted PFC packet.

(For additional information, see [QoS Profiles](#) in the “QoS and HQoS” chapter)

It is suggested that the priority in the VLAN header match the QoS profile priority when traffic ingresses at the edge of the network so that the traffic can be more easily controlled as it traverses through the network.

Fabric Port Configuration. This feature also configures the fabric between ingress and egress ports to optimize PFC behavior. When the ingress and egress ports are located on separate BlackDiamond I/O modules or different nodes in a SummitStack, note that some older systems do not support the enhanced fabric mode required for PFC. The following applies:

- For BlackDiamond 8800 switches, the BlackDiamond 8900-MSM128 is needed. If other MSMs are installed, a log message is issued indicating that system performance for PFC will not be optimal.
- In a SummitStack, PFC cannot be enabled until the following command is executed:

```
configure stacking protocol enhanced
```

The fabric can be set up to support the flow control messages only in the following switches:

- Summit X460
- Summit X480
- Summit X650
- Summit X670

If any other Summit switch attempts to join the stack after the initial configuration of PFC, it is not allowed to join.

If your situation does not respond well to having flow control enabled on the fabric links, you can turn off flow control in the fabric by using the following command:

```
configure forwarding flow-control fabric [auto | off]
```

Configuring Priority Flow Control . With PFC, it is expected that both RX and TX be enabled or disabled.

To enable PFC, use the following command:

```
enable flow-control [tx-pause {priority <priority>} | rx-pause {qosprofile <qosprofile>}] ports [all | <port_list>]
```

To disable PFC, use the following command:

```
disable flow-control [tx-pause {priority <priority>} | rx-pause {qosprofile <qosprofile>}] ports [all | <port_list>]
```

Example. The network needs to transport FCoE (Fiber Channel over Ethernet) traffic which is intermixed with other more typical LAN traffic on the same Ethernet network. FCoE needs a lossless transport and PFC can be used to enable this. You define QoS profiles for all eight traffic priorities. At the network level, it is decided that FCoE traffic will be assigned to priority 3 (which corresponds to QP4) and the remaining traffic is assigned to one or more other priorities. For this example, it is also assumed that the priority bits in the incoming packets are also 3.

One mechanism that can be used for this classification is the use of Access Control Lists (ACLs) that match on the FCoE ethertypes (0x8906 and 0x8914) using the ethernet-type qualifier with an action of QoS profile QP4 for both rules. Other traffic can be classified to other priorities. Once this configuration is applied, FCoE is now separated from the other Ethernet traffic and is assigned a priority of 3 through the switch.

PFC is enabled at the ports that will see FCoE traffic, in this case, ports 1:1, 2:3, and 6:5. Since FCoE is assigned to QP4, you would enable the receive PFC for QoS profile to be QP4 and, in this example, would also enable PFC with a transmit priority of 3. The enable commands would then read as follows:

```
enable flow-control tx-pause priority 3 ports 1:1,2:3,6:5
enable flow-control rx-pause qosprofile qp4 ports 1:1,2:3,6:5
```

Once this configuration is complete, if a switch ingress port detects congestion, it will send PFC packets to the remote link partner and will respond to PFC packets from the remote link partner by stopping transmit.

Abnormal Configuration Examples. Following are examples of abnormal configuration scenarios that can occur:

- If you attempt to configure PFC on a port that does not support it, an error message similar to the following is issued and you will be informed that PFC cannot be configured on that port:

```
BD8810.1# enable flow-control tx-pause priority 3 port 1:1
Error: Port 1:1 does not support Priority Flow Control.
```

- If you attempt to configure PFC on a port in a system that has older MSM models, the PFC configuration will succeed as long as the user port supports it, but a log message will be issued indicating that overall PFC operation is not optimal.

```
01/22/2010 14:14:37.88 <Warn:HAL.VLAN.PFCSubopt> MSM-A: Priority Flow Control is
enabled but system behavior will not be optimal. Older modules in the system
cannot be programmed for fabric flow control.
```

- When PFC is enabled on a port, IEEE 802.3x will be disabled. If, after enabling PFC, you try to modify RX or TX pause parameters, an error message similar to the following will be issued explaining the dependency on PFC configuration:

```
BD8810.1# enable flow-control tx-pause port 1:1
Error: Priority Flow Control is currently enabled on port 1:1 and is mutually
exclusive with TX and RX pause configuration. TX and RX pause configuration
cannot be done until PFC is disabled on this port.
```

- When PFC configuration is attempted on older versions of BlackDiamond 8900-10G24X-c modules or Summit X650 switches that do not support PFC, as described in the following conditions, the switch will attempt the configuration.

- If you try to configure PFC on older BlackDiamond 8900-10G24X-c modules or Summit X650 switches that do not support PFC.
- If a BlackDiamond 8900-10G24X-c module or Summit X650 switch in a SummitStack that supports PFC is replaced with a version that does not support PFC.
- If a slot is preconfigured as an 8900-10G24X-c module, PFC is configured, and a version of the module that does not support PFC is inserted.

Under any of these conditions, the scenario is flagged and the following log message is issued to alert you to the misconfiguration:

```
01/22/2010 14:14:37.88 <Warn:HAL.VLAN.PFCUnsuprt> MSM-A: Port 4:1 is on an older
model of the 8900-10G24X-c or X650 and does not support Priority Flow Control.
8900-10G24X-c 41632B, X650 17001B and 17002B, and VIM-10G8X 17012B are new models
that support PFC.
```

- If you try to configure PFC on a port in a SummitStack before you have configured the SummitStack for enhanced mode, the following error message is issued:

```
Slot-1 Stack.7 # enable flow-control rx-pause qosprofile qp1 port 1:1
Error: The stack is not configured for enhanced stacking mode. Issue the
command "configure stacking protocol enhanced" to enable this mode and retry the
PFC configuration.
```

- On Summit X670 and X670V switches, if you try to configure PFC on alternate stack ports or SummitStack-V80 native stack ports, the following error message is issued:

```
07/18/2011 10:42:07.60 <Warn:HAL.Port.FabFlowCtrlUnsuprt> Slot-1: Slot 3 does not
support fabric flow control messages on alternate stack ports or V80 native stack
ports.
```

Turning Off Autonegotiation on a Gigabit Ethernet Port

In certain interoperability situations, you need to turn autonegotiation off on a fiber gigabit Ethernet port. Although a gigabit Ethernet port runs only at full duplex, you must specify the duplex setting.

The following example turns autonegotiation off for port 1 (a 1 Gbps Ethernet port) on a module located in slot 1 of a modular switch:

```
configure ports 1:1 auto off speed 1000 duplex full
```

The 10 Gbps ports do not autonegotiate; they always run at full duplex and 10 Gbps speed.

Running Link Fault Signal

The 10 Gbps ports support the Link Fault Signal (LFS) function. This function, which is always enabled, monitors the 10 Gbps ports and indicates either a remote fault or a local fault. The system then stops transmitting or receiving traffic from that link. After the fault has been alleviated, the system puts the link back up and the traffic automatically resumes.

The Extreme Networks implementation of LFS conforms to the IEEE standard 802.3ae-2002.



NOTE

To display the part number of the module, use the `show slot <slot_number>` command. (All the modules on the BlackDiamond 8800 series switch support LFS.)

Although the physical link remains up, all Layer 2 and above traffic stops. The system sends LinkDown and LinkUp traps when these events occur. Additionally, the system writes one or more information messages to the syslog, as shown in the following example for a BlackDiamond 8800 series switch:

```
09/09/2004 14:59:08.03 <Info:vlan.dbg.info> MSM-A: Port 4:3 link up at
10 Gbps speed and full-duplex
09/09/2004 14:59:08.02 <Info:hal.sys.info> MSM-A: 4:3 - remote fault
recovered.

09/09/2004 14:59:05.56 <Info:vlan.dbg.info> MSM-A: Port 4:3 link down
due to remote fault
09/09/2004 14:59:05.56 <Info:hal.sys.info> MSM-A: 4:3 - remote fault.

09/09/2004 15:14:12.22 <Info:hal.sys.info> MSM-A: 4:3 - local fault
recovered.
09/09/2004 15:14:11.35 <Info:vlan.dbg.info> MSM-A: Port 4:3 link up at
10 Gbps speed and full-duplex

09/09/2004 15:13:33.56 <Info:vlan.dbg.info> MSM-A: Port 4:3 link down
due to local fault
09/09/2004 15:13:33.56 <Info:hal.sys.info> MSM-A: 4:3 - local fault.
09/09/2004 15:13:33.49 <Info:vlan.dbg.info> MSM-A: Port 4:3 link down
```

due to local fault

In Summit series switches, on disabling the 10 Gbps ports, the following message is logged to the syslog:

```
08/26/2008 06:05:29.29 Port 1 link down - Local fault
```

This message is logged even when the 10 Gbps port is currently operating in 1 Gbps in the case of Summit X650 series switches.



NOTE

A link down or up event may trigger Spanning Tree Protocol topology changes or transitions.

Turning off Autopolarity

Summit Family Switches, SummitStack, and BlackDiamond 8800 Series Switches only. The autopolarity feature allows the system to detect and respond to the Ethernet cable type (straight-through or crossover cable) used to make the connection to the switch port or an endstation. This feature applies only to the 10/100/1000 BASE-T ports on the switch and copper medium on Summit combination ports.

When the autopolarity feature is enabled, the system causes the Ethernet link to come up regardless of the cable type connected to the port. When the autopolarity feature is disabled, you need a crossover cable to connect other networking equipment and a straight-through cable to connect to endstations. The autopolarity feature is enabled by default.

To disable or enable autopolarity detection, use the following command:

```
configure ports <port_list> auto-polarity [off | on]
```

Where the following is true:

- `port_list`—Specifies one or more ports on the switch
- `off`—Disables the autopolarity detection feature on the specified ports
- `on`—Enables the autopolarity detection feature on the specified ports

Under certain conditions, you might opt to turn autopolarity off on one or more ports. The following example turns autopolarity off for ports 5 to 7 on a Summit family switch:

```
configure ports 5-7 auto-polarity off
```

When autopolarity is disabled on one or more Ethernet ports, you can verify that status using the command:

```
show ports information detail
```

IPFIX

BlackDiamond 8900 G96Tc, G48T-xl, G48X-xl, and 10G8X-xl Modules, Summit X460 and X480 Switches, and E4G-400 Cell Site Routers only

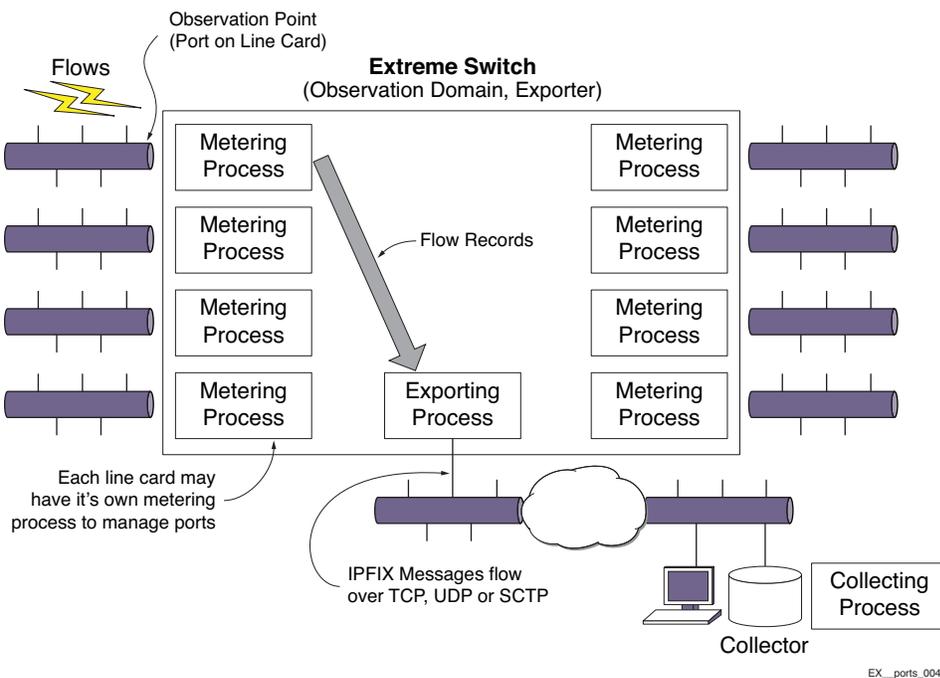
The *IP Flow Information Export (IPFIX)* protocol was created by the IETF as a standard way to capture information about traffic flows passing through network elements in a data network. The protocol consists of a *metering process*, an *exporting process*, and a *collecting process*. This section discusses the metering and exporting processes; the collecting process is not defined by the standard and therefore is outside the scope of this document. The IPFIX protocol is a rival, but complimentary, protocol to sFlow.

This feature is supported only on BlackDiamond 8900 G96Tc, G48T-xl, G48X-xl, and 10G8X-xl modules, Summit X460 and X480 switches, and E4G-400 cell site routers.

The Extreme Networks switch contains various metering processes that gather information about flows through different ports, or *observation points*, on the switch. This information includes: the link state, IPFIX state, flow count, byte count, packet count, flow record count and premature exports. The metering process then sends the information to the exporting process in the switch which handles communication, using TCP, UDP, or SCTP transport protocols, over the network to a collecting process.

Figure 9 shows these processes.

Figure 9: IPFIX Processes



Limitations

This feature has the following limitations:

- The flow key definition is limited to the L2 and L3 header fields the hardware provides.
- There is a 8K flow limit per port—4K for ingress and 4K for egress.

Enabling IPFIX

To enable IPFIX on a port and provide a check to ensure that the port being enabled has hardware support for IPFIX, use the following command:

```
enable ip-fix ports [<port_list> | all] {ipv4 | ipv6 | non-ip | all_traffic}
```

If the port does not support IPFIX, an error message is displayed.

To disable an enabled port, use the following command:

```
disable ip-fix ports [<port_list> | all]
```

To enable or disable IPFIX globally and override an individual port enable, use the following command:

```
[enable | disable] ip-fix
```

Configuring IPFIX Flow Key Masks

Flow keys define what data in the packet header identifies a unique flow to the hardware. On each port, there is a flow key for IPv4, IPv6, and non-IP traffic type data. Following are the flow keys together with the size of the field:

IPv4:

- Source IP Address (32)
- Destination IP Address (32)
- L4 Source Port (16)
- L4 Destination Port (16)
- L4 Protocol (8)
- TOS (DSCP +ECN) (8)

IPv6:

- Source IP Address (128)
- Destination IP Address (128)
- L4 Source Port (16)
- L4 Destination Port (16)
- Next Header (8)
- IPv6 Flow Label (20)
- TOS (DSCP +ECN) (8)

Non-IP:

- Source MAC Address (48)
- Destination MAC Address (48)
- VLAN ID (12)
- VLAN Priority (3)
- Ethertype (16)
- VLAN Tagged (1)

By default, IPFIX uses all the above listed flow keys and all bits. You can override this on a global basis and specify exactly which keys to use. The template that specifies the structure of the information that is communicated from the exporter to the collector will then contain only those specified keys.

To specify the flow keys to use for each of the three traffic types, use the following commands:

```
configure ip-fix flow-key ipv4 {src-ip} {src-port} {dest-ip} {dest-port} {protocol}
{tos}
```

```
configure ip-fix flow-key ipv6 {src-ip} {src-port} {dest-ip} {dest-port} {next-hdr}
{tos} {flow-label}
```

```
configure ip-fix flow-key nonip {src-mac} {dest-mac} {ethertype} {vlan-id} {priority}
{tagged}
```

To reset to the all keys default, use the following command:

```
unconfigure ip-fix flow-key
```

You can then define masks for the IPv4 and IPv6 source and destination address fields on a per port basis. Use the following commands:

```
configure ip-fix ports <port_list> flow-key ipv4 mask [source | destination] ipaddress
<value>
```

```
configure ip-fix ports <port_list> flow-key ipv6 mask [source | destination] ipaddress
<value>
```

Example. You can use the flow keys and masks to minimize the information sent to the collector and aggregate certain types of flows. A common use of the non-default values may be to see all traffic from a user only instead of each individual flow. For example, in the case of IPv4:

```
configure ip-fix flow-key ipv4 src-ip dest-ip
```

Then, by configuring the mask on a port, the aggregation could be further restricted to meter only individual subnets. For example, with a 255.255.255.0 mask:

```
configure ip-fix ports 3:1 flow-key ipv4 mask source ipaddress 255.255.255.0
configure ip-fix ports 3:1 flow-key ipv4 mask destination ipaddress 255.255.255.0
```

To unconfigure the masks, use the following command:

```
unconfigure ip-fix ports <port_list> flow-key mask
```

Configuring IPFIX Parameters on a Port

These are optional commands; when not configured, the defaults are used.

To configure whether to meter on ingress and/or egress ports, use the following command:

```
configure ip-fix ports <port_list> [ingress | egress | ingress-and-egress]
```

(The default is `ingress`.)

To configure whether to meter all, dropped only, or non-dropped only records, use the following command:

```
configure ip-fix ports <port_list> record [all | dropped-only | non-dropped]
```

(The default is `all`.)

To unconfigure these IPFIX settings on a port or group of ports, use the following command. This restores the configuration to the defaults for those ports. It does not enable or disable IPFIX.

```
unconfigure ip-fix ports <port_list>
```

Configuring Domain IDs

Observation points are aggregated into observation domains. The entire switch operates as one domain. The IPFIX protocol contains an observation domain ID in the flow records that are sent to the collector. The collector can use the domain to correlate records to their origin. How this field is used is up to a given collector. To configure a domain ID, use the following command:

```
configure ip-fix domain <domain_id>
```

Configuring a Collector

To export flow records using the IPFIX protocol, you must first configure a collector. Only a single collector is allowed. You can specify the source IP address and VR to use when sending from the switch to a given collector. When not specified, the system defaults to the switch IP address the traffic exits.

To specify, use the following command:

```
configure ip-fix source ip-address <ipaddress> {vr <vrname>}
```

To reset back to the default of using the switch IP, use the following command:

```
unconfigure ip-fix source ip-address
```

You can specify the IP address, port number, transport protocol and VR for a collector. Use the following command:

```
configure ip-fix ip-address <ipaddress> {protocol [sctp | tcp | udp]} {L4-port <portno>} {vr <vrname>}
```

To unconfigure this, use the following command:

```
unconfigure ip-fix ip-address
```

Unconfiguring IPFIX

To unconfigure IPFIX completely use the following command. This removes all port and collector configuration and disables all ports.

```
unconfigure ip-fix
```

Displaying IPFIX Information

To display the global state, the collector information and the ports that are enabled for IPFIX, use the following command:

```
show ip-fix
```

To display information about per port metering, use the following command:

```
show ports {<port_list> | tag <tag>} ip-fix {detail | no-refresh}
```

To show whether IPFIX is enabled on a specific port together with port IPFIX configuration, use the following command:

```
show ports {mgmt | <port_list> | tag <tag>} information {detail}
```

WAN PHY OAM

Summit X450a and Summit X480 Series Switches only.

You can configure WAN PHY OAM on the Summit X450a and Summit X480 series switches whether or not they are included in a SummitStack. The WAN-PHY OAM feature is a subset of the SONET/SDH overhead function and the WAN PHY interface is defined in IEEE 802.3ae.

The WAN-PHY feature is available on LW XENPAK ports on the Summit X450a switches. The LW XENPAK provides an interface connection between a 10G Ethernet and a 10G SONET/SDH network from a 10G Ethernet equipment port.

Summit X480 series switches are WAN-PHY capable on 10G XFP ports. XFP ports can operate in both LAN and WAN modes. For such ports, the WAN PHY configuration commands that are shown in the following section, are available only after setting the ports to “WAN PHY” mode using the `configure ports <port_list> mode {lan | wan-phy}` command.

Configuring WAN PHY OAM Parameters

The following are configurable WAN PHY OAM parameters:

- Framing—either SONET or SDH; default is SONET.
- Clock source—either internal or line; default is line.
- J0 section trace string—16-character string; default is the IEEE default value, which has no string representation.
- J1 path trace string—16-character string; default is the IEEE default value, which has no string representation.
- Loopback—line, internal, or off; the default is off

To set the framing, use the following command:

```
configure ports <port_list> wan-phy framing [sonet | sdh]
```

To choose the clock source, use the following command:

```
configure ports <port_list> wan-phy clocking [line | internal]
```

To set a section trace ID, use the following command:

```
configure ports <port_list> wan-phy trace-section <id_string>
```

To set a path trace ID, use the following command:

```
configure ports <port_list> wan-phy trace-path <id_string>
```

To set a WAN PHY port to loopback, use the following commands:

On X450a series switches:

```
configure ports <port_list> wan-phy loopback [line | off]
```

On Summit X480 series switches:

```
configure ports <port_list> wan-phy loopback {off | internal | line}
```

To reset the configuration parameters of a WAN PHY port to default values, use the following command:

```
unconfigure ports [<port_list> | all] wan-phy
```

Displaying WAN PHY OAM Information

You display information on the WAN PHY ports using the following commands:

```
show ports {mgmt | <port_list> | tag <tag>} information {detail}
show ports {<port_list> | tag <tag>} wan-phy configuration
show ports {<port_list> | tag <tag>} wan-phy errors {no-refresh}
show ports {<port_list> | tag <tag>} wan-phy events {no-refresh}
show ports {<port_list> | tag <tag>} wan-phy overhead {no-refresh}
```

Configuring Switching Mode—Cut-through Switching

Summit X650 and X670 Series Switches, BlackDiamond X8 Series Switches and BlackDiamond 8900 Series Modules Only

The default switching mode for ExtremeXOS switches is store-and-forward. Store-and-forward switching requires the complete receipt of a packet prior to transmitting it out the interface. The packet is stored in its entirety in packet memory and can be validated via the frame CRC by the switch prior to forwarding it to the next hop.

On the Summit X650 series switches (whether or not included in a SummitStack) and BlackDiamond 8900 series modules, you can configure the switch to a cut-through switching mode. Cut-through switching allows the switch to begin transmitting a packet before its entire contents have been received thereby reducing the overall forwarding latency for large packet sizes.

Of the BlackDiamond 8900 series modules, only the 8900-10G24X-c and 8900-MSM128 fully support cut-through switching mode. The BlackDiamond 8900-G96T-c has partial support; it can operate only the switching fabric in cut-through mode.

The following limitations apply to the cut-through switching feature:

- Cut-through mode cannot be achieved for packet sizes less than or equal to 384 bytes.
- Error packets may be forwarded when using cut-through mode. These packets need to be detected and discarded by one of the downstream switches, routers, or the ultimate end station.

In some circumstances, store-and-forward is automatically used. Following are examples:

- Cut-through mode cannot be achieved when switching a packet internally from a low-speed front-panel port (1G or 10G) to a higher-speed fabric port. In this case, store-and-forward switching will automatically be used. However, cut-through switching can be used when switching between equal speed ports or from a higher-speed interface to a lower-speed interface.
- Store-and-forward is used for packets that are switched to multiple egress ports in scenarios such as VLAN flooding and multicast.
- Store-and-forward is used whenever the egress interface is congested including when QoS rate shaping is in effect.

Configuring Switching Mode

To configure the switching mode, use the following command:

```
configure forwarding switching-mode [cut-through | store-and-forward]
```

To display the switching mode settings, use the following command:

```
show forwarding configuration
```

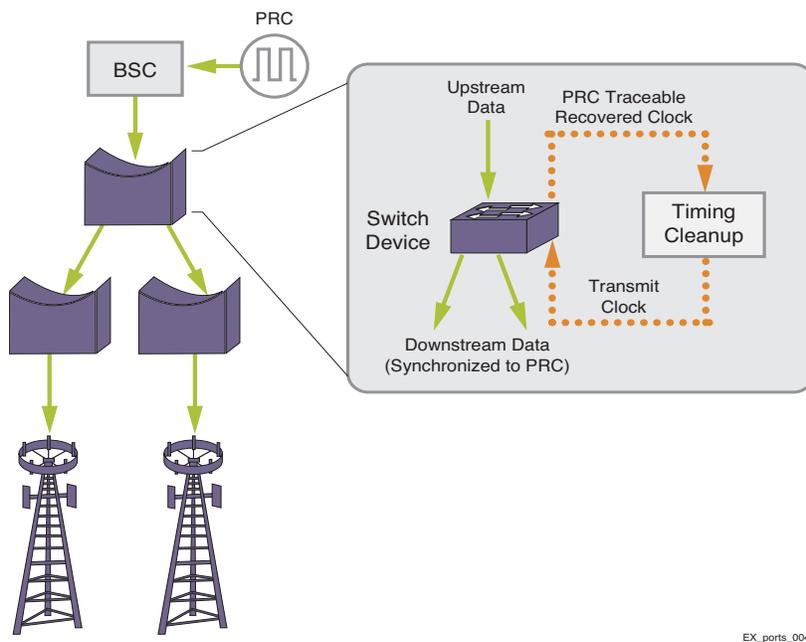
SyncE

Summit X460-24x and X460-48x Switches and E4G-200 and E4G-400 Cell Site Routers

Synchronous Ethernet (SyncE) is defined in ITU-T recommendations G.8262/G.8264. This feature provides the capability for the hardware to synchronize the clock time that is used for data transmission to a reference clock. This primary reference clock (PRC) comes from a base station controller (BSC).

Figure 10 shows a SyncE structure.

Figure 10: SyncE Structure



EX_ports_0048

On the switch, one port is configured to be the source for the master interface clock. A second port can be configured to be the source for a backup reference clock should the master be disconnected or fail. Up to two ports can be specified as a clock source. Data transmission for all other ports are synchronized to the master interface clock. If the master port fails, clock accuracy is maintained. When the ExtremeXOS software detects the failure, it enables the secondary port for the clock. If, at any time, the master port comes back up, it again becomes the source of the primary clock still with accuracy maintained.

It is not necessary for data from the clock master or backup ports to be sent over the other interfaces to maintain synchronization. Only the transmission timing is affected.

The Ethernet Synchronization Messaging Channel (ESMC) is defined by ITU-T for synchronous Ethernet links. ESMC PDUs guide hardware to pick primary clock source and send ESMC messages downstream with clock accuracy details for systems to synchronize.

Limitations and Requirements

SyncE is supported on 100Mbps/1Gbps ports, and it is also available on E4G-400 XGM 10G Ethernet ports if present.

For synchronous Ethernet (SyncE), the following ports are supported on each platform:

- X460-24X: Input Ports 1-28, Output Ports 1 - 28
- X460-48X: Input Ports 1-48, Output Ports 1 - 48
- E4G-200: All Ethernet ports
- E4G-400: All Ethernet ports including XGMS 10G ports if present

Clocking Subsystem Selection for E4G-200 and E4G-400

The E4G-200 and E4G-400 have clock sources beyond SyncE. The clock which drives all of the ports on a switch may be selected from:

- SyncE.
- PTP – an optional 1588v2 module.
- TDM – an optional module which has multiple T1/E1 interfaces for TDM/Ethernet interworking.
- BITS – Building Integrated Timing Supply. A connector capable of receiving a timing signal provided by other building equipment.

SyncE for E4G Stacking

The network timing clock can be distributed across different nodes in a stack using 10G alternate stacking links.

Clock distribution on a stack required a specific configuration:

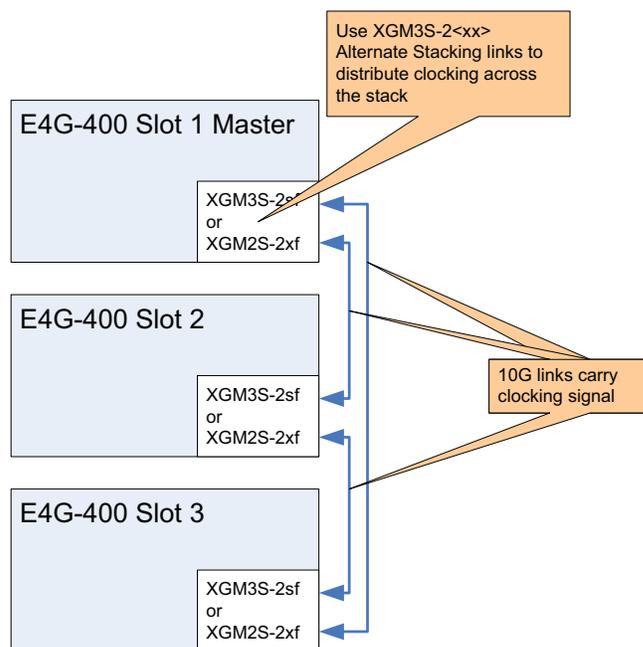
- All nodes in a stack must be SyncE capable.
- All nodes in a stack must support SyncE on stacking links.

Currently only E4G-400 with an XGM3S card in slot A is capable of supporting SyncE for stacking.

The E4G-400 can use any stacking module used by the X460 series. However, the native stacking modules cannot carry network timing signals throughout the stack. Only the XGM3S plug in modules have that capability. If clock distribution is desired in an E4G-400 stack, alternate stacking must be used with an XGM3S module in slot A.

Figure 11 shows E4G Stack Clocking.

Figure 11: E4G-400 Stack Clocking



SyncE for E4G Stacking Limitations.

- Currently SyncE is only supported on stacks with EG4-400 with XGM3S-2SF or XGM3-2XF cards in Slot A configured as alternate stacking.
- SyncE cli commands are only available if all nodes in the stack have stacking ports capable of SyncE distribution.
- If SyncE is configured on stacking and a new node not capable of SyncE is added to the stack, an error message will be logged as not capable and the node will be allowed to join. This will break the SyncE, so the user must be careful when adding a new node into the SyncE stack.

Configuring SyncE

A link flap occurs in the following scenarios:

- Link is configured as clock source via the command `configure network-clock sync-e clock-source source-1/source-2`.
- Link is unconfigured for clock source via the command `unconfigure network-clock sync-e ports <port>`.
- When a valid input clock is selected via the port configured as clock source.
- When a valid input clock becomes unavailable via the port configured as clock source.

To enable SyncE on ports, use the following command:

```
enable network-clock sync-e port [<port_list> | all]
```

To disable SyncE on ports, use the following command:

```
disable network-clock sync-e port [<port_list> | all]
```

To configure SyncE on ports, use the following command:

```
configure network-clock sync-e [source-1 | source-2] port <port>
```

To unconfigure SyncE on ports, use the following command:

```
unconfigure network-clock sync-e [port <port>]
```

To display the configuration and port state, use the following command:

```
show network-clock sync-e port [<port-list>] {details}
```

To display SyncE as part of the port configuration, use the following command:

```
show ports {mgmt | <port_list> | tag <tag>} information {detail}
```

To configure the input network clock source, use the following command:

```
configure network-clock clock-source input {[sync-e | ptp | tdm | [bits-rj45 | bits-bnc] {quality-level <value>}} | region [E1 | T1]}
```

To configure the output network clock source, use the following command:

```
configure network-clock clock-source output {bits-bnc-1 [1pps | 8KHz] bits-bnc-2 [E1 | T1 | 10MHz]}
```

To display the configured network clock source information, use the following command:

```
show network-clock clock-source
```

TDM PWE and TDM Timing

Introduction

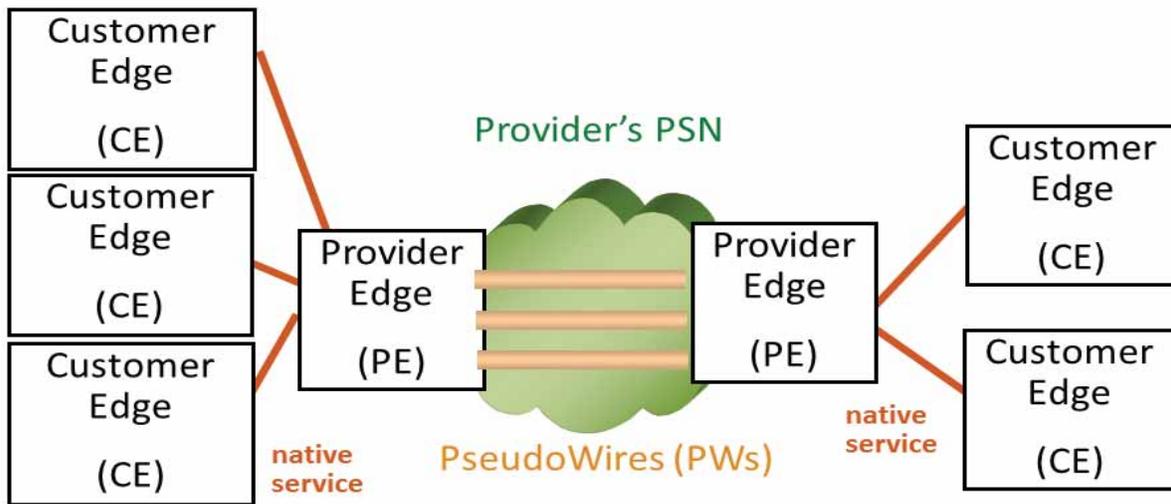
Time-Division Multiplexed circuits can be transported via Pseudo-wires (TDM PWE) using tunnels based on Ethernet, IP/UDP or MPLS.

This method of transporting TDM circuits over a Packet Switching Network is also known as Circuit Emulation Service (CES).

This feature is available only on the E4G-400 and E4G-200 cell site routers.

[Figure 12](#) explains the different components of a pseudo-wire.

Figure 12: Components of a Pseudo-wire

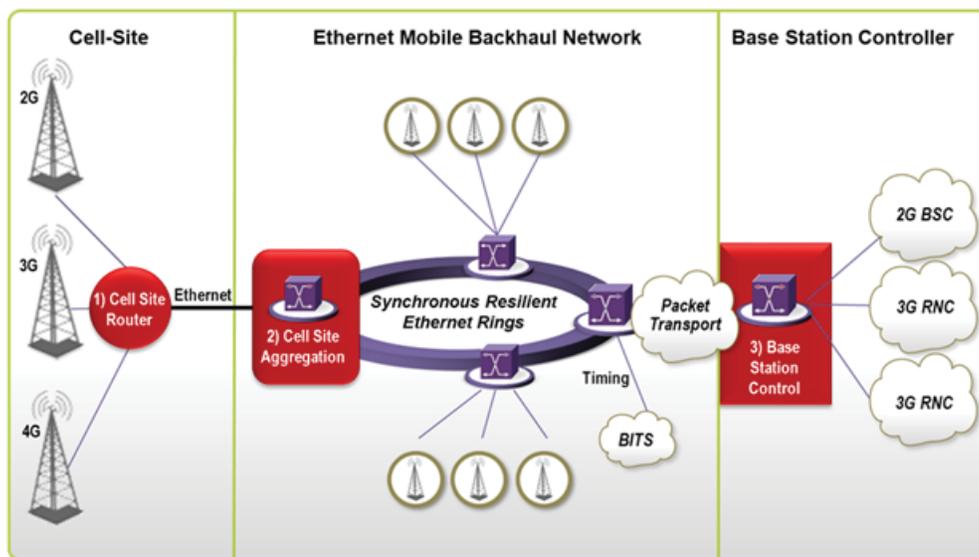


A pseudo-wire is an emulation of point-to-point circuit over a Packet Switching Network (typically Ethernet). It emulates the operation of a “transparent wire” carrying the service.

- **Ethernet Pseudo-wires:** When the service being carried over the “wire” is Ethernet, it is referred as Ethernet Pseudo-wires. L2VPN is an example of Ethernet Pseudo-wires.
- **TDM Pseudo-wires:** When the service being carried over the “wire” is TDM, it is referred as TDM Pseudo-wires.

Figure 13 shows a typical mobile-backhaul network.

Figure 13: Mobile-Backhaul Network

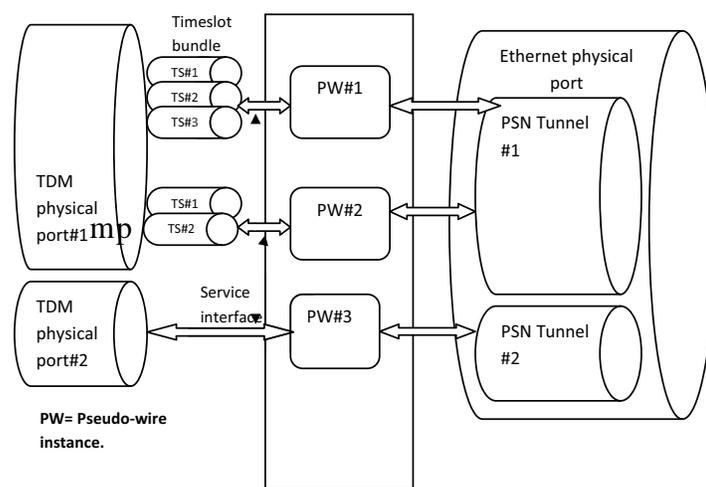


- **Cell Site:** This is the Radio Access Customer Network Edge and refers to that part of the Mobile network that includes 2G (T1/E1 Connectivity), 3G and 4G radio towers.

- **Cell Site Router:** The Cell-Site Router backhauls the traffic from the radio towers over the Ethernet network. Several 2G, 3G and 4G radio towers can be connected to the Ethernet mobile backhaul at the same time via the Cell Site Router.
- **Cell Site Aggregation Router:** This aggregates the multiple Ethernet links from various Cell Site Routers and also the T1/E1 links (that are co-located with it) and transports them over the Mobile core. It is likely that Cell Site Aggregation routers are connected to each other via multiple synchronous Gigabit Ethernet rings.
- **Base Station Control:** Terminates TDM pseudo-wires and hand-off cell site (TDM/ATM) traffic to BSC/RNC devices.

Figure 14 shows the components involved in supporting TDM pseudo-wires.

Figure 14: TDM Pseudo-wire Entities



TDM pseudo-wires can be realized as structure-agnostic transport or SAToP (RFC4553) and structure-aware transport (RFC5086) transports of TDM circuits. The components involved in both the types of pseudo-wires are mostly similar. In Figure 14, PW#1 and PW#2 are realized using structure-aware transport of TDM circuits, while PW#3 is realized using structure-agnostic transport of TDM circuit.

- **SAToP:** This is a pseudo-wire encapsulation of TDM bit streams (T1/E1) without any cognizance of the structure of the TDM bit-streams. The entire frame received over the T1/E1 port is treated as data and sent over the pseudo-wire. This method has the following advantages:
 - Low overhead
 - Lower end-to-end delay
- **CESoPSN:** In this method, there is a structure awareness of the TDM bit streams (signals), meaning the data that's encapsulated is NXDS0. This method has the benefit of lower packetization delay when transporting several timeslots. CESoP supports channel-associated signaling (CAS) for TDM interfaces.

Packet Encapsulation Formats Supported by ExtremeXOS. The packet encapsulation formats of the different pseudo-wire transports supported by ExtremeXOS are shown below:

- MEF-8 (Ethernet) based encapsulation

**NOTE**

The Ethertype used for MEF-8 encapsulation is 0x88D8.

- IP/UDP-based encapsulation (RFC 4553 and RFC 5086)
- MPLS-based encapsulation (RFC 4385 and RFC 5287)

Figure 15 shows the packet encapsulation formats supported by ExtremeXOS.

Figure 15: Packet Encapsulation Formats Supported by ExtremeXOS

MEF-8 (Ethernet) Based Encapsulation							
DA (6 bytes)	SA (6 bytes)	VLAN Header (4 bytes)	ETHER TYPE (0x88D8) (2 bytes)	ECID (Emulated Circuit Identifier) (4 bytes)	Control Word (4 bytes)	TDM PAYLOAD	

P/UDP-Based Encapsulation (RFC 4553 and RFC 5086)							
DA (6 bytes)	SA (6 bytes)	VLAN Header (4 bytes)	ETHER TYPE (0x0800) (2 bytes)	IP Header (20 bytes)	UDP Header (8 bytes)	Control Word (4 bytes)	TDM PAYLOAD

MPLS-Based Encapsulation (RFC 4385 and RFC 5287)							
DA (6 bytes)	SA (6 bytes)	VLAN Header (4 bytes)	ETHER TYPE (0x8847) (2 bytes)	Tunnel Label (4 bytes)	PW Label (4 bytes)	Control Word (4 bytes)	TDM PAYLOAD

Configuring TDM Hierarchy

The switch boots up in the E1 hierarchy by default (the TDM ports are configured to operate in E1 mode).

For T1 mode of operation, the hierarchy must be configured followed by the save and reboot of the switch. After reboot, the switch boots up in T1 hierarchy based on the configuration saved and the TDM ports operate in T1 mode.

Other TDM configurations can be performed after setting up the switch in the correct hierarchy.

**NOTE**

For a TDM line where TDM services and/or CES pseudo-wires have been configured, and the hierarchy need to be changed, we recommend that you first remove or reset all of the CES pseudo-wires, TDM services, and TDM line configurations before you configure the TDM hierarchy.

To configure the TDM hierarchy for the switch (T1 or E1), use the following command:

```
configure tdm hierarchy [t1 | e1]
```

Understanding TDM Ports Numbering

ExtremeXOS supports 16 TDM ports on E4G-200 and E4G-400 cell site routers.

The TDM ports are numbered from 1 to 16 in the face-plate of the switch. However, when the TDM ports are configured using the ExtremeXOS CLI, the TDM ports are numbered sequentially after the Ethernet ports. [Table 26](#) shows the port number mapping in E4G-200 and E4G-400 cell site routers.

Table 26: TDM Port Number Mapping for E4G-200 and E4G-400

Cell Site Router	Module	Panel TDM Port Numbers	TDM Port Numbers in ExtremeXOS CLI
E4G-400	E4G-B16T1E1	1–16	35-50
E4G-200	E4G-F16T1E1	1–16	13–28

Note that the panel TDM port numbers are different from the TDM port numbers used for the configuration.

In E4G-200, the port number 13 in the ExtremeXOS CLI refers to the TDM port 1 in the face-plate. Similarly, port 14 in the ExtremeXOS CLI refers to TDM port 2 in the face-plate and so on.

In E4G-400, the port number 35 in the ExtremeXOS CLI refers to the TDM port 1 in the face-plate. Similarly, port 36 in the ExtremeXOS CLI refers to TDM port 2 in the face-plate, and so on.

Examples:

To enable TDM port 2 in E4G-400, use the port number 36.

```
enable port 36 tdm
```

To enable TDM port 5 in E4G-200, use the port number 17.

```
enable port 17 tdm
```



NOTE

tdm indicates that the port number in the enable/disable/configure port commands is a TDM port.

Configuring TDM Ports

To configure the framing used on TDM ports, use the following command:

```
configure ports <port_list> tdm framing [d4 | esf | [basic | mf] {crc4} | unframed]
```

To configure the line coding scheme to be used on TDM ports, use the following command:

```
configure ports <port_list> tdm line-coding [b8zs | hdb3 | ami]
```

To configure the cable length and receiver gain to be used on TDM ports, use the following command:

```
configure ports <port_list> tdm cable-length [ short-haul [110 | 220 | 330 | 440 | 550 | 660] | long-haul line-build-out [0db | 75db | 150db | 225db]]
```

To configure the local and network loopback mode for TDM ports, use the following commands to

enable and disable loopback:

```
enable ports <port_list> tdm loopback [local | network [line | payload]]
disable ports <port_list> tdm loopback [local | network [line | payload]]
```

To configure or clear a display string for TDM ports, use the following commands:

```
configure ports <port_list> tdm display-string <string>
unconfigure ports <port_list> tdm display-string
```

To enable or disable TDM ports, use the following commands:

```
enable ports [<port_list> | all] tdm
disable ports [<port_list> | all] tdm
```

To configure the transmit clock source for TDM ports, use the following command:

```
configure ports <port_list> tdm clock-source [line | network | [adaptive |
differential] ces <ces_name>]
```

To configure the recovered clock and quality level for TDM ports, use the following command:

```
configure ports <port_list> tdm recovered-clock {quality-level <value>}
```

To unconfigure the recovered clock for TDM ports, use the following command:

```
unconfigure ports <port_list> tdm recovered-clock
```

To configure the idle code to be used on TDM ports, use the following command:

```
configure tdm service circuit <service_name> seized-code <seized_code>
```

To configure signaling on TDM ports, use the following command:

```
configure ports <port_list> tdm signaling [bit-oriented | robbed-bit | none]
```



NOTE

A given TDM port cannot belong to more than one TDM service when the port is in unframed mode.

Configuring TDM Services

To create or delete a TDM service, use the following commands:

```
create tdm service circuit <service_name>
delete tdm service circuit [<service_name> | all]
```

To add a port or port/time-slot to a TDM service, use the following command:

```
configure tdm service circuit <service_name> add port <port> {time-slots
[<time_slot_list> | all]}
```

To delete a port from a TDM service, use the following command:

```
configure tdm service circuit <service_name> delete port <port>
```

To configure the idle code and seized code, use the following command:

```
configure tdm service circuit <service_name> seized-code <seized_code>
```

To configure the trunk-conditioning value for alarm conditions, use the following command:

```
configure tdm service circuit <service_name> trunk-conditioning <trunk_conditioning>
```

**NOTE**

- A given {TDM port, time-slot} combination cannot belong to more than one TDM service.
- A TDM service can belong to only one TDM pseudo-wire.
- In the framed mode of operation on E1 hierarchy, timeslot 1 cannot be added to a TDM service. Additionally, if TDM port is configured as multiframed, timeslot 17 cannot be added to a TDM service.
- Time-slots from different TDM ports cannot belong to the same TDM service.

Configuring and Managing CES Pseudo-Wires

Use the following commands to configure Circuit Emulation Service (CES) pseudo-wires.

To create or delete a CES pseudo-wire, use the following commands:

```
create ces <ces_name> psn [mef8 | udp | mpls]
delete ces [<ces_name> | all]
```

To enable or disable the administrative status of a CES pseudo-wire, use the following commands:

```
enable ces [<ces_name> | all]
disable ces [<ces_name> | all]
```

To manually add an IPv4 peer (far-end) for a CES pseudo-wire, use the following command:

```
configure ces <ces_name> add peer ipaddress <ipaddress> [fec-id-type pseudo-wire
<pw_id> {lsp <lsp_name>} | udp-port local <src_udp_port> remote <dst_udp_port> vlan
<vlan_name>]
```

To manually add an Ethernet (MEF-8) peer (far-end) for a CES pseudo-wire, use the following command:

```
configure ces <ces_name> add peer mac-address <mac_address> ecid local <tx_ecid>
remote <rx_ecid> vlan <vlan_name>
```

To delete a peer of a CES pseudo-wire, use the following command:

```
configure ces <ces_name> delete peer [ipaddress <ipaddress> | mac-address
<mac_address>]
```

To add or delete a TDM service on a CES pseudo-wire, use the following commands:

```
configure ces <ces_name> add service <service_name>
configure ces <ces_name> delete service
```

To configure the jitter-buffer value for a CES pseudo-wire, use the following command:

```
configure ces <ces_name> jitter-buffer <min_jbf> {max <max_jbf>}
```

To configure the payload-size value for a CES pseudo-wire, use the following command:

```
configure ces <ces_name> payload-size <bytes>
```

To configure the quality of service (QoS) profile for a CES pseudo-wire, use the following command:

```
configure ces <ces_name> qosprofile <qosprofile>
```

To configure the filler pattern for a CES pseudo-wire, use the following command:

```
configure ces <ces_name> filler-pattern <byte_value>
```

To configure Loss of Packet State (LOPS) on a CES pseudo-wire, use the following command:

```
configure ces <ces_name> lops-threshold [entry <num_packets_for_entry> {exit  
<num_packets_for_exit>} | exit <num_packets_for_exit>]
```

To configure time-to-live (TTL) on a CES pseudo-wire, use the following command:

```
configure ces <ces_name> ttl <ttl_value>
```

To enable or disable the CES pseudo-wire peer, use the following commands:

```
[enable | disable] ces <ces_name> peer ipaddress <ipaddress>
```

To configure DSCP value on a CES pseudo-wire, use the following command:

```
configure ces <ces_name> dscp <dscp_value>
```



NOTE

- Payload size can be reconfigured only after disabling the TDM pseudo-wire.
- TDM service can be removed from a TDM pseudo-wire only after the Peer Configuration of the TDM pseudo-wire is removed.
- The CES pseudo-wire configured for recovering clock cannot be deleted when it is configured as the clock source for the TDM port. Change the TDM port transmit clock source before deleting the pseudo-wire.

Displaying TDM PW Configurations

To display TDM port information, use the following command:

```
show ports {<port_list>} tdm information {detail}
```

To display TDM port configuration information, use the following command:

```
show ports {<port_list>} tdm configuration {no-refresh}
```

To display the TDM port alarms, use the following command:

```
show ports {<port_list>} tdm alarms {no-refresh}
```

To display TDM service interface information, use the following command:

```
show tdm service {circuit} {<service_name>}
```

To display CES pseudo-wire parameters, use the following command:

```
show ces {<ces_name>} {detail}
```

To display CES peer information, use the following command:

```
show ces peer [ipaddress <ipaddress> | mac-address <mac_address>]
```

To display TDM port information, use the following command:

```
show ports {<port_list>} tdm {no-refresh}
```

To display TDM hierarchy information, use the following command:

```
show tdm hierarchy
```

To display CES clock recovery information, use the following command:

```
show ces {<ces_name>} clock-recovery
```

TDM Port and PW Statistics

To display specified TDM port error counters, use the following command:

```
show ports {<port_list>} tdm errors {near-end} {total | intervals | current {no-refresh}}
```

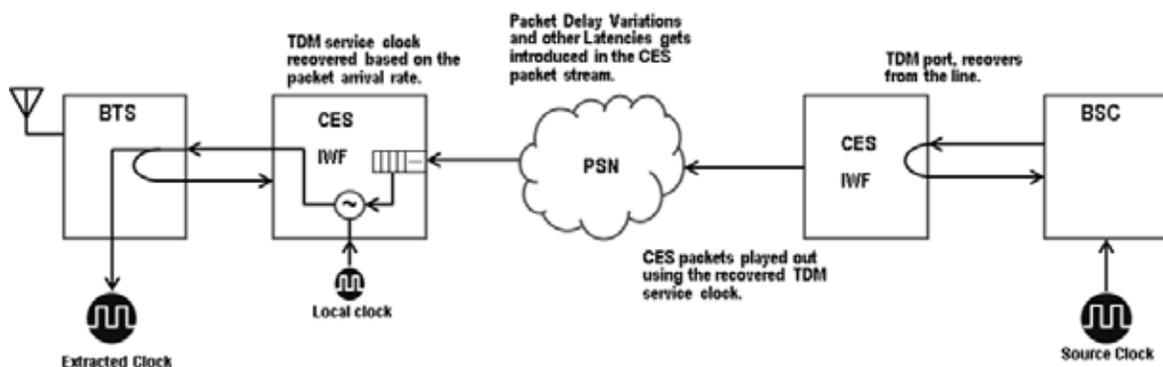
To display specified CES pseudo-wire error counters, use the following command:

```
show ces {<ces_name>} errors {total | intervals | day-intervals | current {no-refresh}}
```

Understanding Adaptive Clock Recovery

The clock to drive TDM ports can be recovered from a TDM pseudo-wire using the Adaptive Clock Recovery (ACR) algorithm. ACR recovers the TDM service clock based on the packet arrival rate and typically employed when no other clock is available in the network to achieve synchronization.

Figure 16: Adaptive Clock Recovery



The adaptive clock recovery uses techniques to filter out the Packet Delay Variations (PDV) introduced in the packet stream by the PSN and recovers the TDM service clock.

The Wander and the Jitter budgets are defined by G.8261 deployment cases (case 1-a, 2-a, 2-b). Network deployments that differ from above cases require deriving the budgets based on the deployment model.

Limitations:

- Only one TDM port can be timed using the clock recovered from the pseudo-wire.
- The pseudo-wire can only time the TDM port that is attached as a service circuit.

- The clock recovered from the pseudo-wire cannot be used as a system clock source for synchronization. This implies that the pseudo-wire recovered clock cannot be carried through Sync-E or PTP or BITS.
- When configuring a SAToP pseudo-wire for clock recovery, the TDM payload bytes carried in pseudo-wire should be a multiple of 32.
- Adaptive clock recovery cannot filter out the low frequency wander introduced by 'beating effect'.

Understanding TDM Transmit Clock Configuration

The TDM transmit clock is configured using the clock-source command. The TDM line can be configured to use one of the following clock sources for transmit:

- **Line:** The clock recovered from the received TDM stream on the TDM port is used as a transmit clock source on the same TDM port.
- **Adaptive:** The transmit clock source for the TDM port is the clock recovered from the PSN pseudo-wire packets. The transmit clock is adaptively recovering clock from the pseudo-wire packet arrival rate.
- **Network clock:** The transmit clock source for the TDM port is the common synchronized clock in the system. The system clock could be synchronized to one of the following clock sources: SyncE, 1588v2, BITS or a clock recovered from the TDM port.

Understanding TDM Port Alarms

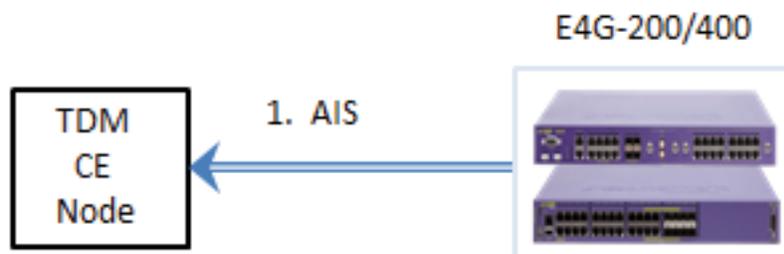
The alarm events from the TDM port that are detected and the alarm response transmitted on the TDM port are listed in the following section. The alarm response on the TDM port/time-slot(s) depends on the port or time-slot(s) configuration state. The port or time-slot is said to be in disconnected or in idle configuration state when they are not added to a TDM service. The port or time-slot(s) are said to be connected if they are part of a TDM service. In idle state, depending on the framing configuration on the port, the alarm response would vary. The alarms generated and the alarm events detected are logged.

TDM Port Alarms in Unframed mode.

AIS Alarm Generation

The TDM ports generate an Alarm Indication Signal (AIS) alarm by default on the ports that are not connected to a service. On ports that are connected to a service, the AIS alarm is generated to indicate pseudo-wire faults.

Figure 17: AIS Alarm

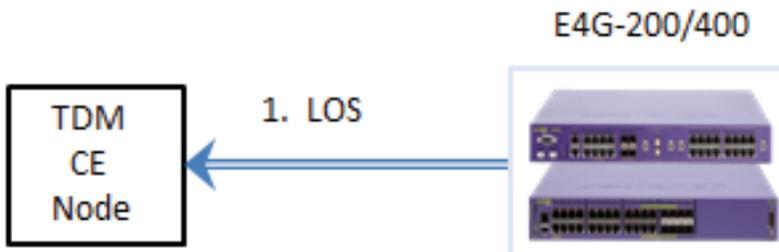


E4G switches do not detect AIS alarm events in unframed mode of operation.

LOS Alarm Generation

The TDM ports generate Loss of Signal (LOS) alarm on the ports that are administratively disabled. The alarm is cleared when the port is enabled.

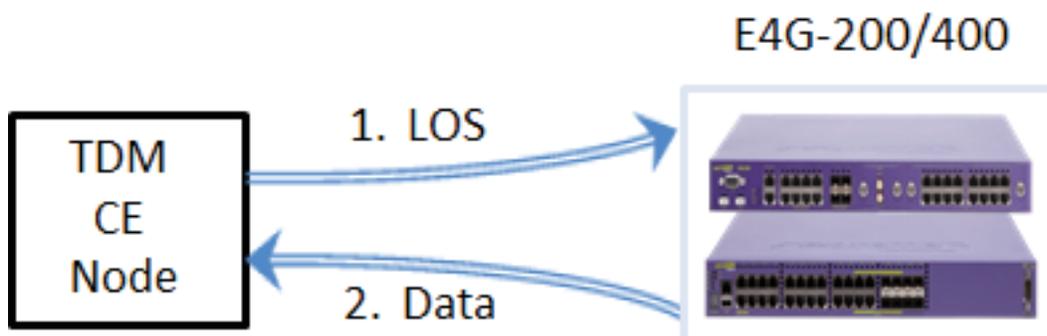
Figure 18: LOS Alarm Generation



LOS Alarm Response

The TDM ports detect a Loss of Signal alarm event. No specific data is played out as a response for this alarm event. However, when the port is not a part of TDM service, the preset idle pattern of all ones (or AIS) is played out. If the port is connected to a TDM service bound to a CES pseudo-wire, the TDM data from the remote end of the CES pseudo-wire, is played out, facilitating the tunneling of alarm event response from the remote TDM CE node.

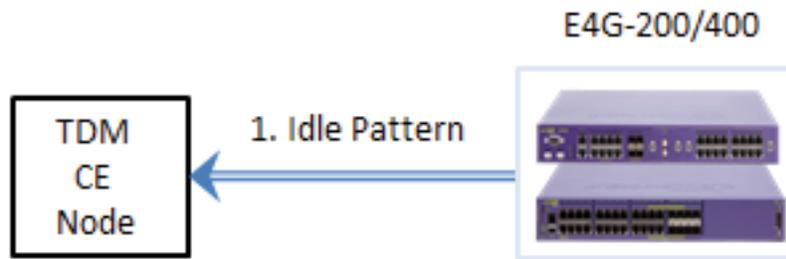
Figure 19: LOS Alarm Response



TDM Port Alarms in Framed Mode.

Default Line State

The TDM ports send out a preset idle pattern of 0xFF on all timeslot(s) that carry TDM data. If signaling multiframe is configured on the TDM port (mf in E1 hierarchy and d4 or esf in T1 hierarchy), a configurable idle code is played out on the signaling channel/bits.

Figure 20: Default Line State

However, the idle pattern is not played out on certain special timeslots, as listed in [Table 27](#) below.

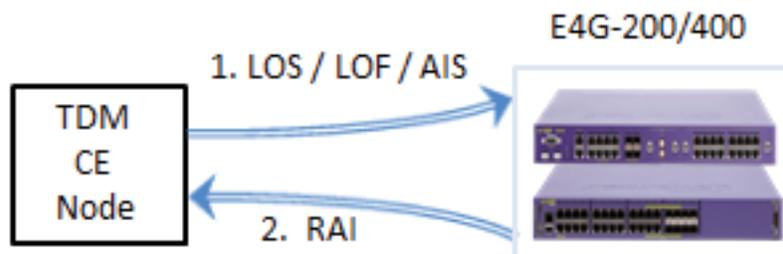
Table 27: Idle Pattern on Timeslots

E1 Hierarchy	
Timeslot - 1	Carries frame alignment signal, CRC and remote alarm information.
Timeslot - 16 (in frame 1/16)	Carries signaling multiframe alignment signal, spare bits and multiframe alarms. Applicable only if port handles signaling multiframe.
T1 Hierarchy	
F-bits	Carries framing alignment signal information. In case of Extended Super Frame formats, carries data link and CRC-6 information.

Note that the idle pattern ployout does not indicate the presence or generation of alarms and is presented here for information purpose.

LOS/LOF/AIS Alarm Response

The Loss of Signal, Loss of Frame and Alarm Indication Signal events are detected and a Remote Alarm Indication is played out as alarm response. The Framed modes in E1 and T1 hierarchy have specific bits in the frame formats for indicating the remote TDM CE interface about the faults.

Figure 21: LOS/LOF/AIS Alarm Response

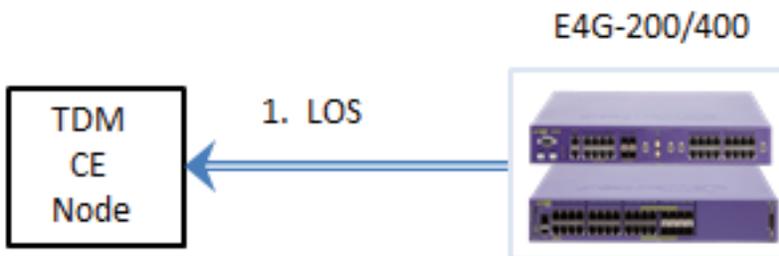
The following framing types configured on the CE node and on the E4G node are considered as incompatible in the E4G node. This would result in detection of Loss of Frame alarm. The Loss of Signaling Multiframe and the Loss of CRC Multiframe are detected as Loss of Frame alarm events.

Table 28: Framing Types

Hierarchy	Framing in E4G node	Framing in Remote CE node
E1	Basic	Unframed
	Signaling multiframe	Unframed Basic
T1	CRC4 enabled	CRC4 disabled
	Super frame (D4)	Unframed Extended super frame (ESF)
	Extended super frame (ESF)	Unframed Super frame (D4)

LOS Alarm Generation

The TDM ports generate Loss of Signal alarm on the ports that are administratively disabled. The alarm is cleared when the port is enabled.

Figure 22: LOS Alarm Generation

TDM Port Alarms and Remedies

Table 29 shows the TDM port alarm conditions detected and generated in different configuration setting, with and without the port being part of a TDM service bound to a CES pseudo-wire with suggested remedies.

Table 29: TDM Port Alarms and Remedies

Alarm	Description	Remedy
LOS	This condition occurs on the TDM port when the local end of the TDM port is in Loss of Signal state. The mismatch in the configured hierarchy, cable length or line gain parameters results in the Loss of Signal state in the local end of the TDM port.	The hierarchy configuration and the interface parameters such as cable length or line gain needs to be reviewed. If no configuration deviations are observed, the transmit clocking option in the remote end requires to be reviewed to isolate the possibility of using an unavailable clock.
LOF	This condition occurs on the framed TDM port when the local end of the TDM port is in Loss of Frame state. The mismatch in the transmitted framing format in the local end and the configured framing format in the remote end results in the Loss of Frame state in the local end of the TDM port.	The framing configuration in the local and remote end of the TDM port needs to be reviewed. If no configuration deviations are observed, the fault due to unstable clock can be isolated by performing loopback tests on the local and/or remote end of the TDM port.

Table 29: TDM Port Alarms and Remedies (Continued)

Alarm	Description	Remedy
TxRAI	<p>This condition occurs on the framed TDM port due to either of the two cases:</p> <ul style="list-style-type: none"> When there is a mismatch in the configured and received framing format. In this case, the transmission of remote alarm indication is triggered by the Loss of Frame state in the local end of the TDM port. In the presence of CES pseudo-wires on the TDM port, when the remote end of the CES pseudo-wire sends an RDI (Remote defect indicator) signal, RAI is transmitted on the TDM port. 	<p>If there are CES pseudo-wires defined on the port, the pseudo-wire remote fault can be referred to. In the presence of attachment circuit Tx fault, no action is required. If there are no CES pseudo-wires defined, the framing configuration on the TDM port needs to be reviewed. Additionally, if no configuration deviations are observed, the fault due to unstable clock can be isolated by performing loopback tests on the local and/or remote end of the TDM port. This condition, if occurs on the unframed TDM port, can be cleared by administratively disabling and enabling the TDM port.</p> <p>The following framing configuration in local/remote would cause RAI to be generated from the local end:</p>
RxRAI	<p>This condition occurs on the framed TDM port due to either of the two cases:</p> <ul style="list-style-type: none"> The Loss of Frame state in the remote end of the TDM port. The application associated with the remote end of the TDM port tunnels the alarm indication to the local end. The mismatch in the transmitted framing format in the local end and the configured framing format in the remote end results in the Loss of Frame state in the remote end of the TDM port. 	<p>If this condition occurs due to the Loss of Frame state in the remote end of the TDM port, the framing configuration on the TDM port needs to be reviewed. Additionally, if no configuration deviations are observed, the fault due to unstable clock can be isolated by performing loopback tests on the local and/or remote end of the TDM port. If this condition occurs due to the application associated with the remote end of the TDM port, no action to be taken. This condition, if occurs on the unframed TDM port, can be cleared by administratively disabling and enabling the TDM port.</p>
TxAIS	<p>This condition occurs on the unframed TDM port due to either of the two cases:</p> <ul style="list-style-type: none"> The AIS is transmitted on the TDM port by default in the absence of loopback or CES pseudo-wire configuration. In the presence of CES pseudo-wires on the TDM port, the AIS is transmitted to indicate the remote end pseudo-wire faults, namely, local end loss of packet state and remote end attachment circuit fault. 	<p>If no CES pseudo-wire is configured on the TDM port, no action is required. If CES pseudo-wires are configured on the TDM port, the pseudo-wire fault information should be referred to for the remote end fault indication. This condition, if occurs on a framed TDM port or occurs on an unframed TDM port with no remote end fault indication in the CES pseudo-wire, can be cleared by administratively disabling and enabling the TDM port.</p>
RxAIS	<p>This condition occurs on the framed TDM port when the remote end of the TDM port transmits an AIS alarm indication.</p>	<p>This condition requires no action to be performed. If CES pseudo-wires are present on the TDM port, this condition is signaled as local attachment circuit Rx fault.</p>

Understanding TDM CES Pseudo-wire Alarms

The CES pseudo-wires transport the alarm events detected on the service interface and the alarm events triggered on the PSN transport using the LRM bits in the pseudo-wire control word. The significance and the usage of the LRM bits are covered by RFC4553 for SAToP pseudo-wires and RFC5086 for CESoP pseudo-wires. The end-to-end alarm handling between two E4G units for SAToP and CESoP pseudo-

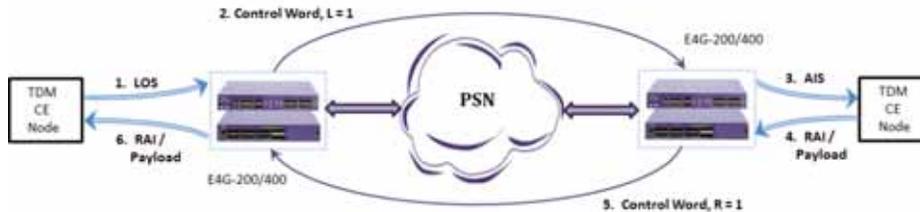
wires are discussed below. The alarms generated and the alarm events detected in the CES pseudo-wires are logged.

CES Alarms in SAToP Pseudo-wires. T

TDM Service LOS Alarm

The Loss of Signal alarm event in the TDM service attached to the SAToP pseudo-wire is handled end-to-end as shown in [Figure 23](#).

Figure 23: SAToP Alarm Handling: TDM Service LOS Alarm



- 1 The Loss of Signal alarm event from the TDM service is detected by the local end E4G node.
- 2 The local end E4G node notifies the alarm condition to the remote end of the CES pseudo-wire by setting the L-bit in the TDM pseudo-wire control word.
- 3 The remote E4G node, upon receiving the CES pseudo-wire with L-bit, ignores the TDM payload carried in the packet and plays out Alarm Indication Signal to the remote TDM CE node.
- 4 The remote TDM CE node sends a response to the Alarm Indication Signal, which could be a specific pattern in case of unframed services, for example, an all ones pattern.
- 5 The remote E4G node sends the alarm response with R-bit set, indicating the packet loss caused due to dropping of packets with L-bit set.
- 6 The local E4G node receives the alarm response packets with R-bit set and forwards the alarm response data to the local TDM CE node.

TDM Service AIS Alarm

The Alarm Indication Signal alarm from the TDM service is not detected by the E4G switch. This alarm is carried transparently to the remote TDM CE node and the alarm response is carried back transparently to the local TDM CE node as pictured. The CES pseudo-wire control word is not updated to reflect the presence of this alarm condition.

Figure 24: SAToP Alarm Handling: TDM Service AIS Alarm

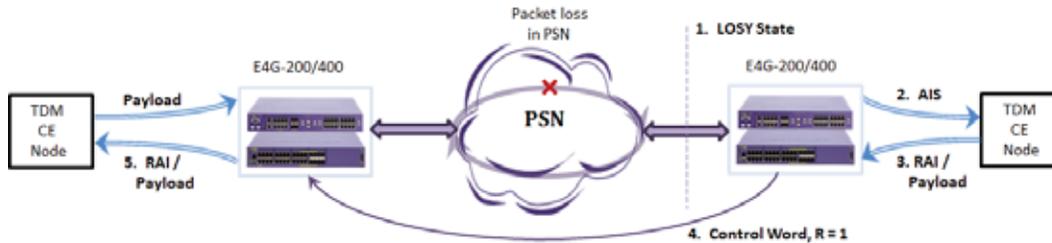


PSN Loss of Packet State

The CES pseudo-wire packets carry the TDM service payload at a constant rate depending on the payload size. The replay of TDM service payload at the remote end of the CES pseudo-wire is done based on the sequence number in the CES pseudo-wire control word. Due to the variable nature of the packet switched network, the CES pseudo-wire streams get dropped in the intermediate nodes. Under

this scenario, the remote end of the CES pseudo-wire is said to be in LOSY state. The LOSY state of the CES pseudo-wire is indicated to the peer by setting the R-bit in the CES pseudo-wire control word.

Figure 25: SAToP Alarm Handling: PSN Loss of Packet State



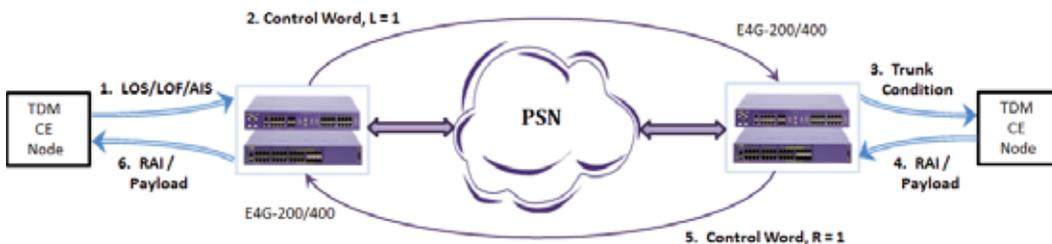
The R-bit in the control word is set on the CES pseudo-wire packets from remote E4G node in LOSY state to the local E4G node, regardless of the RAI pattern received from its local TDM CE node.

CES Alarms in CESoP Pseudo-wires. The handling of CES alarms in CESoP pseudo-wires are more involved due to association of one or more timeslots to a TDM service and hence multiple services originating from a single TDM port with disjoint timeslots. On alarm conditions, the configured trunk condition code for data channels is played out. For signaling channels, the configured seized code pattern is played out.

TDM Service LOS/LOF/AIS Alarm

The Loss of Signal, Loss of Frame and Alarm Indication Signal events in the TDM service attached to the CESoP pseudo-wire is handled end-to-end as shown in [Figure 26](#).

Figure 26: CESoP Alarm Handling: TDM Service LOS/LOF/AIS Alarm

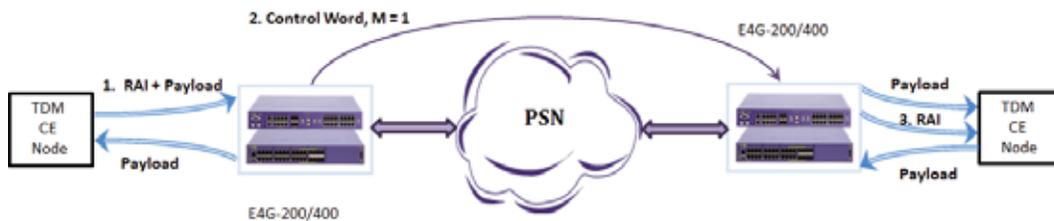


The alarm handling sequence is similar to SAToP pseudo-wires, with an exception that the alarm is indicated only on the specific TDM service bound to the CES pseudo-wires. For instance, if the TDM service has 10 timeslots bound to the CES pseudo-wire, the alarm is indicated by the remote E4G node by playing out the configurable trunk conditioning pattern on those 10 timeslots in the TDM service. If signaling multiframe mode is configured on the TDM port, the configurable seized code pattern is played on the signaling bits.

TDM Service RAI Alarm

The CESoP pseudo-wires indicates the remote E4G node of the Remote Alarm Indication (or Remote Defect Identifier) alarms detected on the TDM service attached to local TDM CE node. The M-bit in the CES pseudo-wire control word is set to indicate the detected alarm. The remote E4G node sets the RAI indication on the TDM port attached to its local TDM CE node in addition to playing out the TDM payload received. [Figure 27](#) shows the alarm handling sequence.

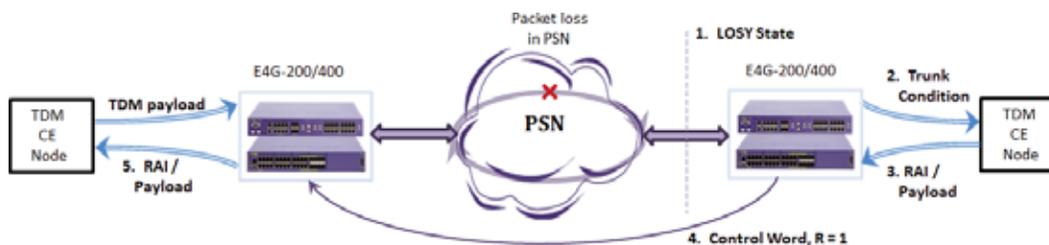
Figure 27: CESoP Alarm Handling: TDM Service RAI Alarm



PSN Loss of Packet State

The CESoP pseudo-wires handle the LOSY state due to loss of CES pseudo-wire packets in the PSN, in the similar way as handled by SAToP pseudo-wires. The configured trunk conditioning code and seized code is played on the timeslots connected to the TDM service instead of AIS. Figure 28 shows the alarm handling sequence.

Figure 28: CESoP Alarm Handling: PSN Loss of Packet State



CES Pseudo-wire Alarms and Remedies

Table 30 lists the CES pseudo-wire alarm conditions detected and generated in the E4G node with the suggested remedies.

Table 30: CES Pseudo-wire Alarms and Remedies

Alarm	Description	Remedy
Local L-bit (Local attachment circuit Rx fault)	This condition occurs when the TDM port in attachment circuit of the CES pseudo-wire is in failure state or is administratively disabled. When the TDM port is in LOS, AIS or LOF condition, the local end of the CES pseudo-wire carries the L-bit in the control word as an indication of the local attachment circuit alarm to the remote end of the pseudo-wire. This condition can be induced by disabling the TDM port administratively. This condition applies for both SAToP and CESoP pseudo-wires.	The alarms associated with the TDM port in the attachment circuit of the CES pseudo-wire can be referred. The L-bit condition is cleared when the associated TDM port is restored from the failure state.

Table 30: CES Pseudo-wire Alarms and Remedies (Continued)

Alarm	Description	Remedy
Local R-bit (Local pseudo-wire LOSY state)	This condition occurs when the local end of the CES pseudo-wire enters the LOSY state. The CES pseudo-wire enters LOSY state when the packets from the remote end of the CES pseudo-wire are lost in the transit. The local end of the CES pseudo-wire carries the R-bit in the control word as an indication of the remote pseudo-wire fault. The CES pseudo-wire stream from the remote end, carrying L-bit would result in LOSY state in the local end of the CES pseudo-wire. Administratively disabling the CES pseudo-wire in the local end would result in the LOSY state in the remote end of the CES pseudo-wire. This condition applies for both SAToP and CESoP pseudo-wires.	If this condition occurs and the CES pseudo-wire is not disabled, the reachability of the CES pseudo-wire peer needs to be checked. If the peer is reachable, occurrence of remote end attachment circuit fault (remote L-bit condition) could be referred to. The R-bit condition is cleared when the remote CES pseudo-wire packets are received.
Local M-bit (Local attachment circuit Tx fault)	This condition occurs when the TDM port in the attachment circuit of the CES pseudo-wire receives remote alarm indication (Rx RAI). The local end of the CES pseudo-wire carries M-bit in the control word to indicate the remote end of the CES pseudo-wire, of the reception of RAI in the local attachment circuit. This condition applies for CESoP pseudo-wires only.	If this condition occurs, the alarms associated with the TDM port in the attachment circuit of the CES pseudo-wire can be referred. The M-bit condition is cleared when the associated TDM port stops receiving RAI indication.
Remote L-bit (Remote attachment circuit Rx fault)	This condition occurs when the TDM port in attachment circuit of the remote CES pseudo-wire is in failure state or is administratively disabled. The remote end of the CES pseudo-wire carries the L-bit in the control word to the local end of the CES pseudo-wire as an indication of the attachment circuit alarm in the remote end of the CES pseudo-wire. This condition can be induced by disabling the TDM port in the remote end of the CES pseudo-wire administratively. This condition applies for both SAToP and CESoP pseudo-wires. This condition causes AIS or trunk conditioning pattern to be transmitted on the local attachment circuit.	If this condition occurs, the TDM port/attachment circuit alarms in the remote end of the CES pseudo-wire can be referred. The L-bit condition is cleared when the TDM port in the remote end of CES pseudo-wire is restored of the failure state.
Remote R-bit (Remote attachment circuit LOSY state)	This condition occurs when the remote end of the CES pseudo-wire enters the LOSY state. When the packets from the local end of the CES pseudo-wire are lost in transit the remote end of the CES pseudo-wire enters LOSY state. This condition also occurs when the local end of the CES pseudo-wire carries L-bit to indicate the remote end of the CES pseudo-wire, of the fault in the local attachment circuit. When the local end of the CES pseudo-wire is administratively disabled, the remote end of the CES pseudo-wire enters LOSY state. This condition applies for both SAToP and CESoP pseudo-wires.	If this condition occurs and the remote end of CES pseudo-wire is not disabled, occurrence of the local end attachment circuit fault (local L-bit condition) could be referred to. If local end of CES pseudo-wire does not carry L-bit, the reachability of the local peer from the remote end of the CES pseudo-wire needs to be checked. The R-bit condition is cleared when the local CES pseudo-wire packets are received in the remote end.
Remote M-bit (Remote attachment circuit Tx fault)	This condition occurs when the TDM port in the attachment circuit of the remote CES pseudo-wire receives remote alarm indication (Rx RAI). The remote end of the CES pseudo-wire carries M-bit in the control word to the local end as an indication of the RAI reception by the attachment circuit. This condition applies for CESoP pseudo-wires only. This condition causes RAI to be transmitted on the local attachment circuit.	If this condition occurs, the alarms associated with the TDM port in the attachment circuit of the remote CES pseudo-wire can be referred. The M-bit condition is cleared when the associated TDM port stops receiving RAI indication

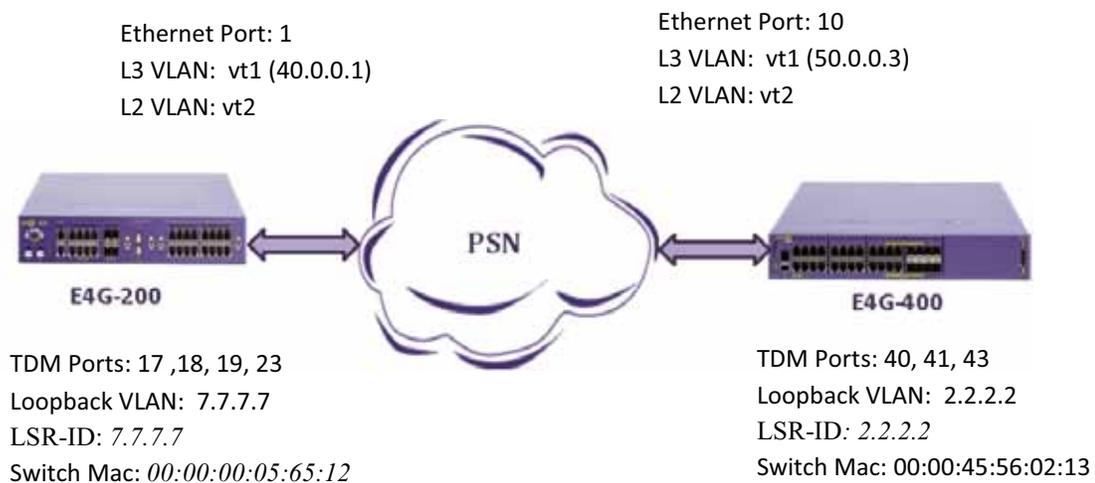
Management Information Base (MIB) Support

The following TDM pseudo-wire related MIBs are supported in ExtremeXOS:

- Read-only support for RFC5604—Managed objects for TDM over Packet Switched Networks (PSNs)
- Read-only support for RFC5601—PW MIB
- Read-only support for RFC2494—Definitions of managed objects for the DS0 and DS0 Bundle Interface Type
- Read-only support for RFC4805—Definitions of managed objects for DS1, J1, E1, DS2 and E2 Interface Types

TDM PW Configurations Examples

Figure 29: TDM PW Configuration Example



To configure TDM UDP SAToP pseudo-wire:

1 Create TDM Service circuit.

On the Left E4G-200 Switch:

```
create tdm service circuit "udp-satop-s1"
configure tdm service circuit "udp-satop-s1" add port 18
```

On the Right E4G-400 Switch:

```
create tdm service circuit "udp-satop-s1"
configure tdm service circuit "udp-satop-s1" add port 41
```

2 Create CES and add TDM Service Circuit.

On the left E4G-200 Switch:

```
create ces udp-ces1 psn udp
configure ces udp-ces1 add service udp-satop-s1
```

On the Right E4G-400 Switch:

```
create ces udp-ces1 psn udp
configure ces udp-ces1 add service udp-satop-s1
```

3 Configure the loopback vlan.**On the left E4G-200 Switch:**

```
create vlan "lpbk"
enable loopback-mode vlan lpbk
configure vlan lpbk ipaddress 7.7.7.7 255.255.255.255
enable ipforwarding vlan lpbk
```

On the Right E4G-400 Switch:

```
create vlan "lpbk"
enable loopback-mode vlan lpbk
configure vlan lpbk ipaddress 2.2.2.2 255.255.255.255
enable ipforwarding vlan lpbk
```

4 Configure the L3 transport vlan to reach the PW peer.**On the left E4G-200 Switch:**

```
create vlan "vt1"
configure vlan vt1 tag 30
configure vlan vt1 add ports 1 tagged
configure vlan vt1 ipaddress 40.0.0.1 255.255.255.0
enable ipforwarding vlan vt1
```

On the Right E4G-400 Switch:

```
create vlan "vt1"
configure vlan vt1 tag 20
configure vlan vt1 add ports 10 tagged
configure vlan vt1 ipaddress 50.0.0.3 255.255.255.0
enable ipforwarding vlan vt1
```

5 Add peer to the CES.**On the left E4G-200 Switch,**

```
configure ces udp-ces1 add peer ipaddress 2.2.2.2 udp-port local 10000 remote 10000
vlan lpbk
```

On the Right E4G-400 Switch,

```
configure ces udp-ces1 add peer ipaddress 7.7.7.7 udp-port local 10000 remote 10000
vlan lpbk
```

To configure TDM UDP CESoP Pseudo-wire:**1 Configure TDM Port Framing mode.****On the left E4G-200 Switch,**

```
configure ports 17 tdm framing mf
```

On the Right E4G-400 Switch,

```
configure ports 40 tdm framing mf
```

2 Create TDM Service Circuit.**On the left E4G-200 Switch,**

```
create tdm service circuit "udp-cesop-s2"
configure tdm service circuit "udp-cesop-s2" add port 17 time-slots 2-4
```

On the Right E4G-400 Switch,

```
create tdm service circuit "udp-cesop-s2"
configure tdm service circuit "udp-cesop-s2" add port 40 time-slots 2-4
```

3 Configure the loopback vlan.

On the left E4G-200 Switch:

```
create vlan "lpbk"  
enable loopback-mode vlan lpbk  
configure vlan lpbk ipaddress 7.7.7.7 255.255.255.255  
enable ipforwarding vlan lpbk
```

On the Right E4G-400 Switch:

```
create vlan "lpbk"  
enable loopback-mode vlan lpbk  
configure vlan lpbk ipaddress 2.2.2.2 255.255.255.255  
enable ipforwarding vlan lpbk
```

4 Configure the L3 transport vlan to reach the PW peer.

On the left E4G-200 Switch:

```
create vlan "vt1"  
configure vlan vt1 tag 30  
configure vlan vt1 add ports 1 tagged  
configure vlan vt1 ipaddress 40.0.0.1 255.255.255.0  
enable ipforwarding vlan vt1
```

On the Right E4G-400 Switch:

```
create vlan "vt1"  
configure vlan vt1 tag 20  
configure vlan vt1 add ports 10 tagged  
configure vlan vt1 ipaddress 50.0.0.3 255.255.255.0  
enable ipforwarding vlan vt1
```

5 Create CES and add the TDM Service Circuit.

On the left E4G-200 Switch:

```
create ces udp-ces2 psn udp  
configure ces udp-ces2 add service udp-cesop-s2
```

On the Right E4G-400 Switch:

```
create ces udp-ces2 psn udp  
configure ces udp-ces2 add service udp-cesop-s2
```

6 Add Peer to the CES.

On the left E4G-200 Switch:

```
configure ces udp-ces1 add peer ipaddress 2.2.2.2 udp-port local 10001 remote 10001  
vlan lpbk
```

On the Right E4G-400 Switch:

```
configure ces udp-ces1 add peer ipaddress 7.7.7.7 udp-port local 10001 remote 10001  
vlan lpbk
```



NOTE

A single loopback vlan is sufficient when configuring multiple pseudo-wires to the same peer and each PW is identified using the unique UDP port numbers configured. The recommended option is to use loopback vlan to specify source IP address to be used in TDM UDP PW. However, the user can also use the normal vlan instead of loopback vlan.

To configure TDM MEF-8 SAToP pseudo-wire:

1 Create TDM Service Circuit.**On the left E4G-200 Switch:**

```
create tdm service circuit "mef8-satop-s3"
configure tdm service circuit "mef8-satop-s3" add port 19
```

On the right E4G-400 Switch:

```
create tdm service circuit "mef8-satop-s3"
configure tdm service circuit "mef8-satop-s3" add port 42
```

2 Create CES and add the TDM Service circuit/**On the left E4G-200 Switch:**

```
create ces mef8-ces3 psn mef8
configure ces mef8-ces3 add service mef8-satop-s3
```

On the right E4G-400 Switch:

```
create ces mef8-ces3 psn mef8
configure ces mef8-ces3 add service mef8-satop-s3
```

3 Configure the L2 transport VLAN to reach the PW peer.**On the left E4G-200 Switch:**

```
create vlan "vt2"
configure vlan vt2 tag 130
configure vlan vt2 add ports 1 tagged
```

On the Right E4G-400 Switch:

```
create vlan "vt2"
configure vlan vt2 tag130
configure vlan vt2 add ports 10 tagged
```

4 Add peer to the CES.**On the left E4G-200 Switch:**

```
configure ces mef8-ces3 add peer mac-address 00:00:45:56:02:13 ecid local 1001
remote 1001 vlan vt2
```

On the right E4G-400 Switch:

```
configure ces mef8-ces3 add peer mac-address 00:00:00:05:65:12 ecid local 1001
remote 1001 vlan vt2
```

To configure TDM MEF-8CESoP PW:**1 Configure TDM Port framing mode.****On the left E4G-200 Switch:**

```
configure ports 17 tdm framing mf
```

On the right E4G-400 Switch:

```
configure ports 40 tdm framing mf
```

2 Create TDM Service Circuit.**On the left E4G-200 Switch:**

```
create tdm service circuit "mef8-cesop-s4"
configure tdm service circuit "mef8-cesop-s4" add port 17 time-slots 6-8
```

On the right E4G-400 Switch:

```
create tdm service circuit "mef8-cesop-s4"
configure tdm service circuit "mef8-cesop-s4" add port 40 time-slots 6-8
```

3 Create CES and add the TDM Service Circuit.

On the left E4G-200 Switch:

```
create ces mef8-ces4 psn mef8
configure ces mef8-ces4 add service mef8-cesop-s4
```

On the right E4G-400 Switch:

```
create ces mef8-ces4 psn mef8
configure ces mef8-ces4 add service mef8-cesop-s4
```

4 Configure the L2 transport VLAN to reach the PW peer.

On the left E4G-200 Switch:

```
create vlan "vt2"
configure vlan vt2 tag 130
configure vlan vt2 add ports 1 tagged
```

On the Right E4G-400 Switch:

```
create vlan "vt2"
configure vlan vt2 tag 130
configure vlan vt2 add ports 10 tagged
```

5 Add peer to the CES,

On the left E4G-200 Switch:

```
configure ces mef8-ces4 add peer mac-address 00:00:45:56:02:13 ecid local 1002
remote 1002 vlan vt2
```

On the right E4G-400 Switch:

```
configure ces mef8-ces4 add peer mac-address 00:00:00:05:65:12 ecid local 1002
remote 1002 vlan vt2
```



NOTE

IP address should not be configured on the transport vlan specified for TDM MEF-8 PW.

To configure MPLS TDM SaTOP Pseudo-wire:

1 Configure the loopback vlan.

On the left E4G-200 Switch:

```
create vlan "lpbk"
enable loopback-mode vlan lpbk
configure vlan lpbk ipaddress 7.7.7.7 255.255.255.255
enable ipforwarding vlan lpbk
```

On the Right E4G-400 Switch:

```
create vlan "lpbk"
enable loopback-mode vlan lpbk
configure vlan lpbk ipaddress 2.2.2.2 255.255.255.255
enable ipforwarding vlan lpbk
```

2 Configure the L3 transport vlan to reach the PW peer.

On the left E4G-200 Switch:

```
create vlan "vt1"
configure vlan vt1 tag 30
configure vlan vt1 add ports 1 tagged
configure vlan vt1 ipaddress 40.0.0.1 255.255.255.0
```

```
enable ipforwarding vlan vt1
```

On the Right E4G-400 Switch:

```
create vlan "vt1"
configure vlan vt1 tag 20
configure vlan vt1 add ports 10 tagged
configure vlan vt1 ipaddress 50.0.0.3 255.255.255.0
enable ipforwarding vlan vt1
```

3 Configure OSPF.

On the left E4G-200 Switch:

```
configure ospf routerid 7.7.7.7
enable ospf
configure ospf add vlan lpbk area 0.0.0.0
configure ospf add vlan vt1 area 0.0.0.0
```

On the right E4G-400 Switch:

```
configure ospf routerid 2.2.2.2
enable ospf
configure ospf add vlan lpbk area 0.0.0.0
configure ospf add vlan vt1 area 0.0.0.0
```

4 Configure MPLS.

On the left E4G-200 Switch:

```
configure mpls add vlan "lpbk"
enable mpls vlan "lpbk"
enable mpls ldp vlan "lpbk"
configure mpls add vlan "vt1"
enable mpls vlan "vt1"
enable mpls ldp vlan "vt1"
configure mpls ldp advertise direct all
configure mpls lsr-id 7.7.7.7
enable mpls protocol ldp
enable mpls
```

On the right E4G-400 Switch:

```
configure mpls add vlan "lpbk"
enable mpls vlan "lpbk"
enable mpls ldp vlan "lpbk"
configure mpls add vlan "vt1"
enable mpls vlan "vt1"
enable mpls ldp vlan "vt1"
configure mpls lsr-id 2.2.2.2
enable mpls protocol ldp
enable mpls
```

5 Create TDM Service Circuit.

On the left E4G-200 Switch:

```
create tdm service circuit "mpls-satop-s6"
configure tdm service circuit "mpls-satop-s6" add port 23
```

On the right E4G-400 Switch:

```
create tdm service circuit "mpls-satop-s6"
configure tdm service circuit "mpls-satop-s6" add port 43
```

6 Create CES and add TDM Service Circuit.

On the left E4G-200 Switch:

```
create ces mpls-ces6 psn mpls
configure ces mpls-ces6 add service mpls-satop-s6
```

On the right E4G-400 Switch:

```
create ces mpls-ces6 psn mpls
configure ces mpls-ces6 add service mpls-satop-s6
```

7 Add peer to the CES.

On the left E4G-200 Switch,

```
configure ces mpls-ces6 add peer ipaddress 2.2.2.2 fec-id-type pseudo-wire 102
```

On the right E4G-400 Switch,

```
configure ces mpls-ces6 add peer ipaddress 7.7.7.7 fec-id-type pseudo-wire 102
```

To configure MPLS TDM CeSOP Pseudo-wire:

1 Follow steps 1–3 of “To configure MPLS TDM SaTOP Pseudo-wire:” above.

2 Configure TDM Port Framing Mode.

On the left E4G-200 Switch:

```
configure ports 17 tdm framing mf
```

On the right E4G-400 Switch:

```
configure ports 40 tdm framing mf
```

3 Create TDM Service Circuit.

On the left E4G-200 Switch:

```
create tdm service circuit "mpls-cesop-s5"
configure tdm service circuit "mpls-cesop-s5" add port 17 time-slots 18-23
```

On the right E4G-400 Switch:

```
create tdm service circuit "mpls-cesop-s5"
configure tdm service circuit "mpls-cesop-s5" add port 40 time-slots 18-23
```

4 Create CES and add TDM Service Circuit.

On the left E4G-200 Switch:

```
create ces mpls-ces5 psn mpls
configure ces mpls-ces5 add service mpls-cesop-s5
```

On the right E4G-400 Switch:

```
create ces mpls-ces5 psn mpls
configure ces mpls-ces5 add service mpls-cesop-s5
```

5 Add peer to the CES.

On the left E4G-200 Switch:

```
configure ces mpls-ces5 add peer ipaddress 2.2.2.2 fec-id-type pseudo-wire 101
```

On the right E4G-400 Switch:

```
configure ces mpls-ces5 add peer ipaddress 7.7.7.7 fec-id-type pseudo-wire 101
```



NOTE

You must configure a loopback vlan with MPLS lsr-id as its IP address.

Using the Precision Time Protocol

IEEE1588v2 (also known as Precision Time Protocol, PTP) is an industry-standard protocol that enables the precise transfer of frequency and time to synchronize clocks over packet-based Ethernet networks. The locally available clock on each network device synchronizes with a grandmaster clock by exchanging timestamps that contain sub-nanosecond granularity. This allows them to deliver very high accuracy to ensure the stability of base station frequency and handovers. The timestamps between master and slave devices are exchanged through PTP event packets. The ExtremeXOS 1588v2 implementation uses the IPv4/UDP transport mechanism PTP packets.



NOTE

The Precision Time Protocol is currently available only on the cell site routers (E4G-200 and E4G-400). For these routers, accurate synchronization of base stations to nanoseconds accuracy is critical to minimize service disruptions and eliminate dropped connections as calls move between adjacent cells.

This section provides the following Precision Time Protocol (PTP) topics:

- [Overview of PTP on page 268](#)
- [Supported PTP Features on page 270](#)
- [Limitations of PTP on page 271](#)
- [Configuring and Displaying PTP Clocks and Data Sets on page 271](#)
- [PTP Configuration Example on page 275](#)

Overview of PTP

The IEEE 1588v2 Precision Time Protocol (PTP) defines a packet-based time synchronization method that provides frequency, phase, and time-of-day information with nanoseconds level of accuracy. PTP relies on the use of carefully time-stamped packets to synchronize one or more slave clocks to a master clock. Synchronous time information is distributed hierarchically, with a grandmaster clock at the root of the hierarchy.

The grandmaster provides the time reference for one or more slave devices. These slave devices can, in turn, act as master devices for further hierarchical layers of slave devices.

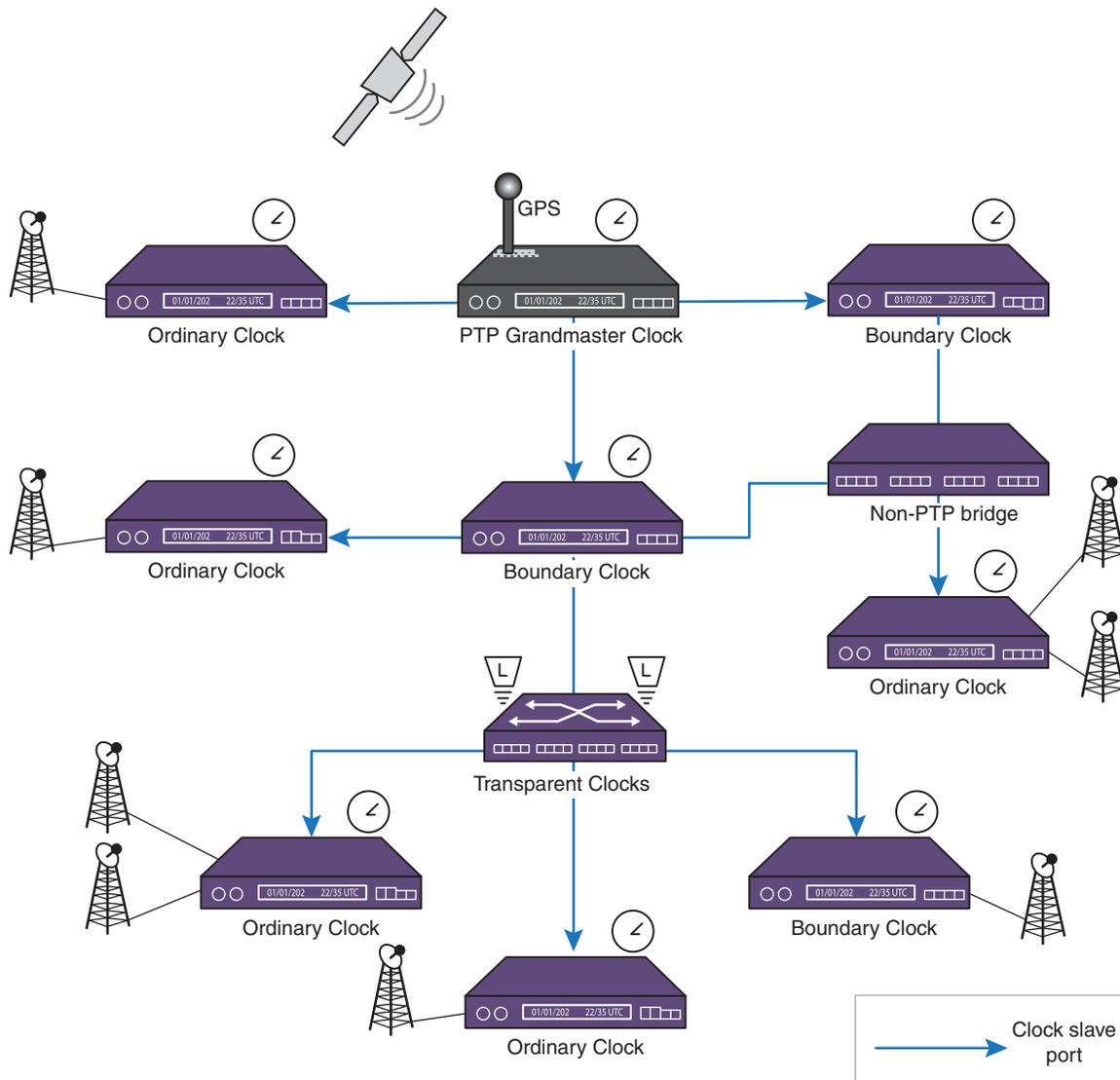
To determine the master-slave hierarchy, a Best Master Clock (BMC) algorithm is used. This algorithm determines which clock is the highest quality clock within a network. The clock elected by BMC (the master clock) then synchronizes all other clocks (slave clocks) in the network. If the BMC is removed from the network or is determined by the BMC algorithm to no longer be the highest quality clock, the algorithm then redefines the new BMC and adjusts all other clocks accordingly. No administrator input is needed for this readjustment because the algorithm provides a fault tolerant behavior.

Synchronizing time across a network requires two essential functions: the measurement of delays and the distribution of time information. Each node is responsible for independently determining the delays across the network links from it to its link partners. Once this is accomplished, periodic time synchronization messages may be sent from the grandmaster clock device to the slave clock devices. Link-based delays wander over time, so periodic delay measurements are required. Because these delays vary slowly, the period between link delay measurements is typically in the order of seconds.

A PTP network must have a grandmaster clock reference and a slave. Between a master and a slave, a PTP network may have multiple boundary clocks, transparent clocks, and non-PTP bridges.

[Figure 30](#) illustrates a typical PTP network hierarchy.

Figure 30: PTP Network Hierarchy



PTP_01

Ordinary clocks are devices with only one PTP port. The grandmaster clock is an ordinary clock acting as a master.

**NOTE**

A PTP port is a logical interface (VLAN / IP interface). A loopback VLAN is added as a clock port to PTP in ExtremeXOS.

Boundary clocks are switches with one or more PTP ports. One PTP port of a boundary clock can act as a slave to a master clock in the network, and the rest of the PTP ports can act as a master for the downstream nodes.

Transparent clocks correct the delays for PTP messages in the correction field.

End-to-end transparent clocks accumulate the residence time in the CorrectionField of the PTP messages. End-to-end transparent clocks do not participate directly in time synchronization with the master clock. The CorrectionField of Sync, Delay Request and Delay Response messages are updated by the end-to-end transparent clocks at each hop. The Signaling and Management messages are not updated by transparent clocks. In a typical setting, boundary and slave clocks are separated by one or more end-to-end transparent clocks that accumulates the residence time in the CorrectionField.

The residence time is defined as the delay between the reception and the transmission of packets through the device. The accumulated CorrectionField value is used by boundary or slave clocks for delay compensation in the time offset correction.

Basic Synchronization

The following event flow describes basic synchronization of PTP:

- 1 The master sends a Sync message to the slave, notes the time (t1) it was sent, and embeds the t1 time in the message.
- 2 The slave receives the Sync message, and notes the time it is received (t2).
- 3 The slave sends a DelayReq message to the master, and notes the time (t3) it was sent.
- 4 The master receives the DelayReq message, and notes the time it is received (t4).
- 5 The master embeds the t4 timestamp in a DelayResp message to the slave.

At the conclusion of this exchange of messages, the slave possesses all four timestamps. You can use these timestamps to compute the offset of the slave's clock with respect to the master, and the mean propagation time of messages between the two clocks.

The computation of offset and propagation time assumes that the master-to-slave and slave-to-master propagation times are equal. Any asymmetry in propagation time introduces an error in the computed value of the clock offset.

End-to-End Transparent Clocks Between Master And Slave

PTP defines the notion of End-to-end transparent clocks which do not participate in time synchronization with master clock. Rather, they simply accumulate the residence time of PTP event messages such as Sync/DelayReq that transit the switch. The residence time is updated in the CorrectionField of these messages.

The transit delay in the link between the hops are not accounted in the CorrectionField by the End-to-end transparent clocks.

Supported PTP Features

The following PTP features are supported in this release:

- Ordinary Clock (slave only)
- Boundary Clock
- End-to-End Transparent Clock
- IPv4 Unicast-UDP transport
- PTP protocol 1-step and 2-step mode with End-to-end delay mechanism.
- Unicast static slaves and masters.

Limitations of PTP

The following are the limitations of the current implementation of PTP:

- Layer 2 transport is not supported
- IPv6-UDP transport is not supported.
- Multicast event messages are not supported.
- 1-step timestamp functionality is not supported on Fiber only 1G ports, 10G ports and stacking ports.
- Peer-to-peer delay mechanism is not supported.
- PTP datasets are not maintained for end-to-end transparent clocks.
- Domain number cannot be assigned to end-to-end transparent clocks.
- Boundary clock does not support synchronizing clocks across multiple domains.
- Distributing clock frequency recovered from SyncE or from BITS or from a TDM port over PTP is not supported.
- Ordinary clock master (Grandmaster) mode is not supported.
- Synchronizing system time with the time recovered from PTP event messages is not supported.
- Time of Day (ToD) output and inputs are not supported.
- Unicast message negotiation on clock ports is not supported.
- PTP cannot be used if network clock source is configured as BITS.

Configuring and Displaying PTP Clocks and Data Sets

PTP Transparent clock

A PTP Transparent clock updates the residence time of the PTP event packets that transit the switch. The switch supports end-to-end delay mechanism and accounts for the residence time for Sync and DelayReq packets in the switch.

To create or delete an End-to-End Transparent clock, use the following commands:

```
create network-clock ptp end-to-end-transparent
delete network-clock ptp end-to-end-transparent
```

To add PTP capable front-panel ports for End-to-End Transparent clock, use the following command:

```
configure network-clock ptp end-to-end-transparent [add | delete] ports <port_list>
{one-step}
```

To display the End-to-End Transparent clock configuration use the following command:

```
show network-clock ptp end-to-end-transparent ports <port_list> {detail}
```

To enable/disable the End-to-End Transparent clock configuration on the front-panel ports, use the following commands:

```
enable network-clock ptp end-to-end-transparent ports <port_list>
disable network-clock ptp end-to-end-transparent ports <port_list>
```

PTP Boundary/Ordinary Clocks

A PTP Boundary or Ordinary clock synchronizes to the master clock through the reception of the PTP event packets. The Boundary and Ordinary clocks can be configured to operate on a single PTP domain. To reconfigure clocks to a different domain, the existing configuration must be deleted.

To create or delete the Boundary or Ordinary clock, use the following commands:

```
create network-clock ptp [boundary | ordinary] {domain <domain_number>}
delete network-clock ptp [boundary | ordinary]
```

To enable or disable the Boundary or Ordinary clock, use the following commands:

```
enable network-clock ptp [boundary | ordinary]
disable network-clock ptp [boundary | ordinary]
```



NOTE

After you enable a boundary clock, you cannot create an ordinary clock. However, you can delete the boundary clock instance and create a new one in order to change the domain number.

To create an ordinary clock instance in the switch that has the boundary clock instance enabled, delete the boundary clock instance, save the configuration and reboot the switch. After the reboot, you can create and enable the ordinary clock instance. Similarly, to create and enable a boundary clock in a switch that has an ordinary clock enabled, delete the ordinary clock instance, save the configuration and reboot the switch. After the reboot you can create and enable a boundary clock. The following message is displayed when you create the boundary clock instance in a device with no prior clock instances:

Warning: The ordinary clock cannot be created after enabling the boundary clock. A delete followed by save and reboot are required to create the ordinary clock.

After you enable a boundary clock instance, if you delete the instance and try to create an ordinary clock instance, the above message is displayed as an error, and the ordinary clock instance is not created.

To configure priority1 and priority2 values of the Boundary and Ordinary clock, use the following commands:

```
configure network-clock ptp [boundary | ordinary] priority1 <priority>
configure network-clock ptp [boundary | ordinary] priority2 <priority>
```

To display the datasets such as Port, Time-properties and Parent of the Ordinary or Boundary clock, use the following commands:

```
show network-clock ptp ordinary {parent | port | time-property}
show network-clock ptp boundary {parent | port | time-property}
```

PTP Boundary/Ordinary Clock Ports

The Boundary and Ordinary clocks operate in 1-step protocol mode. An Ordinary clock can have at most one clock port in slave mode. A Boundary clock can have multiple clock ports in master or slave modes. Multiple unicast master or slave entries can be added to the clock ports.

To add or remove a slave clock port to an Ordinary clock, use the following commands:

```
configure network-clock ptp ordinary add {vlan} <vlan_name> {one-step | two-step}
slave-only
```

```
configure network-clock ptp ordinary delete {vlan} {vlan_name}
```

To add or remove a clock port to the Boundary clock, use the following commands:

```
configure network-clock ptp boundary add {vlan} <vlan_name> {one-step | two-step}
{master-only | slave-only}
```

```
configure network-clock ptp boundary delete {vlan} <vlan_name>
```

To enable or disable a clock port in the Boundary or Ordinary clock, use the following commands:

```
enable network-clock ptp [boundary | ordinary] {{vlan} <vlan_name>}
```

```
disable network-clock ptp [boundary | ordinary] {{vlan} <vlan_name>}
```

To display the clock ports added to the Boundary or Ordinary clock, use the following commands:

```
show network-clock ptp ordinary [{vlan} <vlan_name> | vlan all]
```

```
show network-clock ptp boundary [{vlan} <vlan_name> | vlan all]
```

For Ordinary clocks, only unicast master entries can be added on the slave port. The query interval for unicast announce messages from the slave port is specified in log base 2. To add or remove the unicast master entries on a slave port of the Ordinary clock, use the following commands:

```
configure network-clock ptp ordinary add unicast-master <ipv4_address> {query-interval
<seconds_log_base_2>} {vlan} <vlan_name>
configure network-clock ptp ordinary delete unicast-master <ipv4_address> {vlan}
<vlan_name>
```

The unicast master entries can be added to the slave port of the Boundary clock. The Boundary clock also support addition of unicast master entries on the port of type 'master or slave'. To add or remove unicast master entries on the port of the Boundary clock, use the following commands:

```
configure network-clock ptp boundary add unicast-master <ipv4_address> {query-interval
<seconds_log_base_2>} {vlan} <vlan_name>
configure network-clock ptp boundary delete unicast-master <ipv4_address> {vlan}
<vlan_name>
```

The unicast slave entries can be added to the master port of the Boundary clock. Additionally, these entries can be added to the port of type 'master or slave'. The Ordinary clock do not support addition of unicast slave entries. To add or remove unicast slave entries on the port of the Boundary clock, use the following commands:

```
configure network-clock ptp boundary add unicast-slave <ipv4_address> {vlan}
<vlan_name>
configure network-clock ptp boundary delete unicast-slave <ipv4_address> {vlan}
<vlan_name>
```

To display the unicast-master entries added to the Boundary or Ordinary clock port, use the following commands:

```
show network-clock ptp boundary unicast-master [{vlan} <vlan_name> | vlan all]
show network-clock ptp ordinary unicast-master [{vlan} <vlan_name> | vlan all]
```

To display the unicast-slave entries added to the Boundary clock port, use the following commands:

```
show network-clock ptp boundary unicast-slave [{vlan} <vlan_name> | vlan all]
```

To display the PTP message counters for the peers added to Boundary or Ordinary clock port, use the following commands:

```
show network-clock ptp boundary vlan [<vlan_name> {{<ipv4_address>} [unicast-master |
unicast-slave]} | all] counters
show network-clock ptp ordinary vlan [<vlan_name> {{<ipv4_address>} [unicast-master |
unicast-slave]} | all] counters
```

To clear the PTP message counters for the peers added to Boundary or Ordinary clock port, use the following commands:

```
clear network-clock ptp boundary vlan [<vlan_name> {{<ipv4_address>} [unicast-master |
unicast-slave]} | all] counters
clear network-clock ptp ordinary vlan [<vlan_name> {{<ipv4_address>} [unicast-master |
unicast-slave]} | all] counters
```

The following properties can be configured on the clock ports added to the Boundary and Ordinary clocks:

Sync message interval:

```
configure network-clock ptp [boundary | ordinary] sync-interval <seconds_log_base_2>
{vlan} <vlan_name>
```

DelayReq message interval:

```
configure network-clock ptp [boundary | ordinary} delay-request-interval
<seconds_log_base_2> {vlan} <vlan_name>
```

Announce message interval:

```
configure network-clock ptp [boundary | ordinary} announce interval
<seconds_log_base_2> {vlan} <vlan_name>
```

Announce message timeout period:

```
configure network-clock ptp [boundary | ordinary] announce timeout
<seconds_log_base_2> {vlan} <vlan_name>
```

PTP Clock Recovery State

The PTP clock recovery state (servo state) in the system can be displayed using the following command:

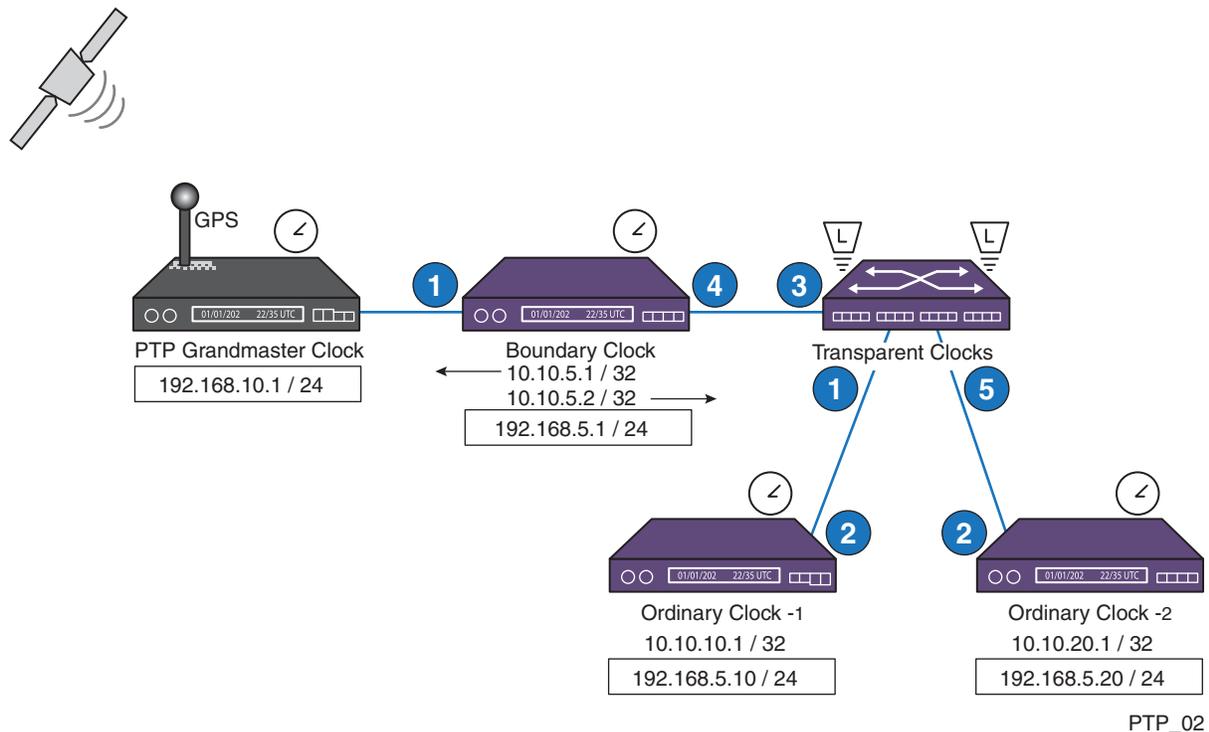
```
show network-clock ptp
```

The clock recovery using PTP event messages undergoes the following servo state changes:

- **Warmup** - The local reference clock is in warmup state. This state signifies that either clock recovery is not configured to use the PTP event messages or no clock recovery messages from the master have been received.
- **FastLoop** - The local reference clock is being corrected and the correction is converging.
- **Bridge** - The local reference clock correction has been interrupted due to changes in the clocking information in the received PTP event messages or loss of PTP event messages.
- **Holdover** - Prolonged loss of PTP event messages puts the local reference clock correction to the holdover state.
- **Normal** - The local reference clock correction has converged and the corrected clock is synchronous to the master clock information received in the PTP event messages.

PTP Configuration Example

Figure 31 shows a sample configuration using the E4G-200/E4G-400 as a transparent clock, a boundary clock, and ordinary clock slaves. .

Figure 31: PTP 1588v2 Configuration Example

The IP address of the grandmaster and the IP address of the clock ports in each of the boundary/ordinary clocks are shown in the topology. The IP addresses that are not enclosed in the boxes are assigned to the clock ports added to boundary/ordinary clocks. The transparent clock node can be configured as L2 or L3. In the configuration example below, the transparent clock node is configured as L2.

**NOTE**

The grandmaster clock should be reachable from the boundary clock and vice versa. Similarly the ordinary clocks should be reachable from the boundary clock and vice versa. The configuration example below does not consider the provisioning methods used to achieve reachability between the switches, and only limits to the PTP 1588v2 and its associated configuration.

End-to-End Transparent Clock Configuration

In this example, the transparent clock is configured as an L2 switch to transit the PTP event stream between boundary and ordinary clocks.

```
create vlan ptp_tc
configure vlan ptp_tc tag 100
configure vlan ptp_tc add port 1,3,5 tagged

create network-clock ptp end-to-end-transparent
configure network-clock ptp end-to-end-transparent add ports 1,3,5 one-step
```

**NOTE**

The transparent clocks accumulate the residence times on 1-step event messages by performing timestamp in ingress PHYs and in egress PHYs. For proper transparent clock operation, you must ensure in the configuration that the PTP events stream ingress and egress through physical ports that are PTP capable.

Ordinary Clock Slave Configuration

The ordinary clock node is configured to synchronize with the boundary clock node. The master clock port's (loopback VLAN) IP address in the boundary clock node is added as "unicast-master" in the ordinary clock node.

**NOTE**

For PTP event messages originating from ordinary clocks (such as DelayReq), the ingress timestamp for updating the CorrectionField is done in the switch. So you must enable the End-to-End Transparent clock on all the egress ports. Ensure that you do not include the non-PTP capable ports in the configuration of possible egress ports through which the boundary is reachable.

Ordinary Clock Slave Configuration (Node-1)

```
create vlan lpbk
configure vlan lpbk tag 10
configure vlan lpbk ipaddress 10.10.10.1/32
enable loopback-mode lpbk
enable ipforwarding lpbk
create vlan ptp_slave
configure vlan ptp_slave tag 100
configure vlan ptp_slave add port 2 tagged
configure vlan ptp_slave ipaddress 192.168.5.10/24
enable ipforwarding ptp_slave

create network-clock ptp end-to-end-transparent
configure network-clock ptp end-to-end-transparent add port 2 one-step

create network-clock ptp ordinary
enable network-clock ptp ordinary
configure network-clock ptp ordinary add vlan lpbk one-step slave-only
configure network-clock ptp ordinary add unicast-master 10.10.5.2 lpbk
```

Ordinary Clock Slave Configuration (Node-2)

```
create vlan lpbk
configure vlan lpbk tag 20
configure vlan lpbk ipaddress 10.10.20.1/32
enable loopback-mode lpbk
enable ipforwarding lpbk
create vlan ptp_slave
configure vlan ptp_slave tag 100
configure vlan ptp_slave add port 2 tagged
configure vlan ptp_slave ipaddress 192.168.5.20/24
```

```
enable ipforwarding ptp_slave

create network-clock ptp end-to-end-transparent
configure network-clock ptp end-to-end-transparent add port 2 one-step

create network-clock ptp ordinary
enable network-clock ptp ordinary
configure network-clock ptp ordinary add vlan lpbk one-step slave-only
configure network-clock ptp ordinary add unicast-master 10.10.5.2 lpbk
```

Boundary Clock Configuration

The boundary clock node is configured to synchronize with the grandmaster node. The grandmaster clock's IP address is added as "unicast-master" in the boundary clock node. The ptp_gm VLAN's configuration depends on the grandmaster for properties such as tag, or IP.



NOTE

For boundary clocks, the End-to-End Transparent clock configuration must be applied on the egress ports through with the Grandmaster and the Ordinary clocks are reachable.

```
configure vlan lpbk-gm tag 51
configure vlan lpbk-gm ipaddress 10.10.5.1/32
enable loopback-mode lpbk-gm
enable ipforwarding lpbk-gm
create vlan lpbk-slaves
configure vlan lpbk-slaves tag 52
configure vlan lpbk-slaves ipaddress 10.10.5.2/32
enable loopback-mode lpbk-slaves
enable ipforwarding lpbk-slaves
create vlan ptp_gm
configure vlan ptp_gm tag 40
configure vlan ptp_gm add port 1 untagged
configure vlan ptp_slave ipaddress 192.168.10.5/24
enable ipforwarding ptp_gm
create vlan ptp_slaves
configure vlan ptp_slaves tag 100
configure vlan ptp_slaves add port 4 tagged
configure vlan ptp_slaves ipaddress 192.168.5.1/24
enable ipforwarding ptp_slaves

create network-clock ptp end-to-end-transparent
configure network-clock ptp end-to-end-transparent add port 1,4 one-step

create network-clock ptp boundary
enable network-clock ptp boundary
configure network-clock ptp boundary add vlan lpbk-gm one-step slave-only
configure network-clock ptp boundary add unicast-master 192.168.10.1 lpbk-gm
configure network-clock ptp boundary add vlan lpbk-slaves one-step master-only
configure network-clock ptp boundary add unicast-slave 10.10.10.1 lpbk-slaves

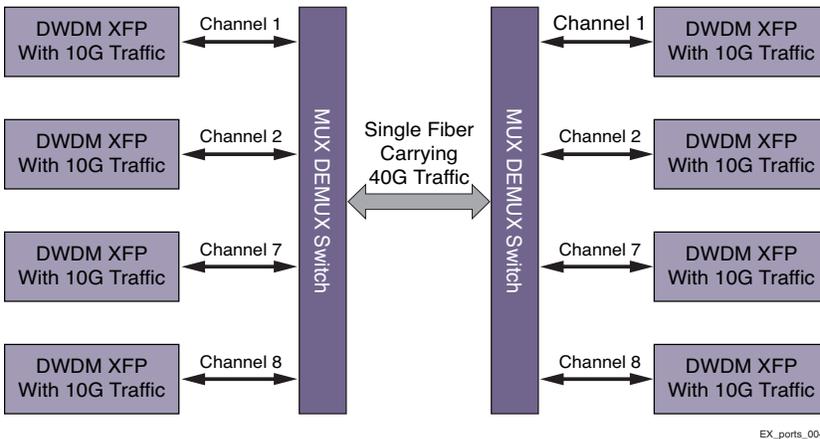
configure network-clock ptp boundary add unicast-slave 10.10.20.1 lpbk-slaves
```

DWDM Optics Support

BlackDiamond 8800 Series Switches and Summit X480 Switches

This feature allows you to configure a *dense wavelength division multiplexing (DWDM)* channel to a DWDM capable tunable XFP module on a port. This provides the capability to multiplex 102x10G traffic over a single fiber. Following is diagram of a DWDM network.

Figure 32: Conceptual Diagram of a DWDM Network



The feature is supported on BlackDiamond 8800 switches with 10G8Xc, 10G4Xc, 10G4Xa or 8900-10G8X-*xl* modules and S-10G1Xc option cards and Summit X480 switches with VIM2-10G4X modules.

For DWDM, there is no standard channel numbering specified by MSA. Extreme Networks devices support ITU standard channel numbers that range from 11 to 6150. The software can map these appropriately to the vendor specific channels internally. For more information about the channel number and wavelength mapping, see Extreme Networks *Pluggable Interface Modules Installation Guide*.

Limitations

This feature has the following limitations:

- Support exists only for Extreme Networks certified XFP modules.
- It may take 500-1000 ms to stabilize the channel once DWDM channel configuration is completed, meaning that the port loses its data transmission capability for that time frame. Links are dropped until the channel is stabilized. However, this is expected behavior when the physical medium is changed.
- When a tunable dense wavelength division multiplexing (TDWDM) XFP module is inserted, the software configures the default channel or the configured channel based on the existing configuration, and the link is likely to be dropped during this process.

Configuring DWDM

To configure DWDM specific channels on the port(s), use the following command:

```
configure port <all | port-list> dwdm channel <channel-number>
```

To configure the DWDM default channel 21 on the port(s), use the following command:

```
configure port <all | port-list> dwdm channel none
```

Displaying DWDM

To display DWDM configuration, use the following commands:

```
show ports {mgmt | <port_list> | tag <tag>} configuration {no-refresh}  
show ports {mgmt | <port_list> | tag <tag>} information {detail}
```

To display the channel scheme for mapping the DWDM wavelengths, use the following command:

```
show dwdm channel-map { <channel_first> { - <channel_last> } } {port <port_num>}
```

Jumbo Frames

Jumbo frames are Ethernet frames that are larger than 1522 bytes, including four bytes used for the cyclic redundancy check (CRC). Extreme products support switching and routing of jumbo frames at wire-speed on all ports. The configuration for jumbo frames is saved across reboots of the switch.

Jumbo frames are used between endstations that support larger frame sizes for more efficient transfers of bulk data. Both endstations involved in the transfer must be capable of supporting jumbo frames. The switch only performs IP fragmentation, or participates in maximum transmission unit (MTU) negotiation on behalf of devices that support jumbo frames.

Guidelines for Jumbo Frames

You need jumbo frames when running the Extreme Networks VMAN implementation. If you are working on a BlackDiamond X8 series switch, BlackDiamond 8800 series switch, SummitStack, or a Summit family switch, you can enable and disable jumbo frames on individual ports before configuring VMANs. For more information on configuring VMANs, refer to [Chapter 13, “VMAN \(PBN\) and PBBN.”](#)

The following information applies to jumbo frames on a SummitStack:

- Jumbo frame support is always enabled and available on Summit family switches that are operating in a SummitStack.

Refer to [“Displaying Port Information”](#) for information on displaying jumbo frame status.

Enabling Jumbo Frames per Port

You can enable jumbo frames per port on the following switches:

- BlackDiamond X8 series switches
- BlackDiamond 8000 c-, e-, xl-, and xm-series modules
- Summit family switches
- E4-G 200 and E4-G 400

When you configure VMANs on BlackDiamond X8, BlackDiamond 8800 series switches, SummitStack, and the Summit family switches, you can enable or disable jumbo frames for individual ports before configuring the VMANs.

Enabling Jumbo Frames



NOTE

Some network interface cards (NICs) have a configured maximum MTU size that does not include the additional 4 bytes of CRC. Ensure that the NIC maximum MTU size is at or below the maximum MTU size configured on the switch. Frames that are larger than the MTU size configured on the switch are dropped at the ingress port.

To enable jumbo frame support, enable jumbo frames on the desired ports. To set the maximum jumbo frame size, use the following command:

```
configure jumbo-frame-size <framesize>
```

The jumbo frame size range is 1523 to 9216. This value describes the maximum size of the frame in transit (on the wire), and includes 4 bytes of CRC plus another 4 bytes if 802.1Q tagging is being used.

Set the MTU size for the VLAN by using the following command:

```
configure ip-mtu <mtu> vlan <vlan_name>
```

Next, enable support on the physical ports that will carry jumbo frames using the following command:

```
enable jumbo-frame ports [all | <port_list>]
```

Path MTU Discovery

BlackDiamond X8 series switches, BlackDiamond 8000 a-, c-, e-, xl-, and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit X250e, X440, X450a, X450e, X460, X480, X650, and X670 series switches, whether or not included in a SummitStack, support path MTU discovery.

Using path MTU discovery, a source host assumes that the path MTU is the MTU of the first hop (which is known). The host sends all datagrams on that path with the “don’t fragment” (DF) bit set which restricts fragmentation. If any of the datagrams must be fragmented by an Extreme switch along the path, the Extreme switch discards the datagrams and returns an ICMP Destination Unreachable message to the sending host, with a code meaning “fragmentation needed and DF set”. When the source host receives the message (sometimes called a “Datagram Too Big” message), the source host reduces its assumed path MTU and retransmits the datagrams.

The path MTU discovery process ends when one of the following is true:

- The source host sets the path MTU low enough that its datagrams can be delivered without fragmentation.
- The source host does not set the DF bit in the datagram headers.

If it is willing to have datagrams fragmented, a source host can choose not to set the DF bit in datagram headers. Normally, the host continues to set DF in all datagrams, so that if the route changes and the new path MTU is lower, the host can perform path MTU discovery again.

IP Fragmentation with Jumbo Frames

The BlackDiamond X8 series switches, BlackDiamond 8000 a-, c-, e-, xl-, and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit X250e, X440, X450a, X450e, X460, X480, X650, and X670 series switches support fragmentation of IP packets. The above support is included whether or not the switches are present in a SummitStack.

ExtremeXOS supports the fragmenting of IP packets. If an IP packet originates in a local network that allows large packets and those packets traverse a network that limits packets to a smaller size, the packets are fragmented instead of discarded.

This feature is designed to be used in conjunction with jumbo frames. Frames that are fragmented are not processed at wire-speed within the switch fabric.



NOTE

Jumbo frame-to-jumbo frame fragmentation is not supported. Only jumbo frame-to-normal frame fragmentation is supported.

To configure VLANs for IP fragmentation:

- 1 Enable jumbo frames on the incoming port.
- 2 Add the port to a VLAN.
- 3 Assign an IP address to the VLAN.
- 4 Enable ipforwarding on the VLAN.
- 5 Set the MTU size for the VLAN, using the following command:

```
configure ip-mtu <mtu> vlan <vlan_name>
```

The ip-mtu value ranges between 1500 and 9194, with 1500 the default.



NOTE

To set the MTU size greater than 1500, all ports in the VLAN must have jumbo frames enabled.

IP Fragmentation within a VLAN

ExtremeXOS supports IP fragmentation within a VLAN. This feature does not require you to configure the MTU size. To use IP fragmentation within a VLAN:

- 1 Enable jumbo frames on the incoming port.
- 2 Add the port to a VLAN.
- 3 Assign an IP address to the VLAN.
- 4 Enable ipforwarding on the VLAN.

If you leave the MTU size configured to the default value, when you enable jumbo frame support on a port on the VLAN you will receive a warning that the ip-mtu size for the VLAN is not set at maximum jumbo frame size. You can ignore this warning if you want IP fragmentation within the VLAN, only. However, if you do not use jumbo frames, IP fragmentation can be used only for traffic that stays within the same VLAN. For traffic that is sent to other VLANs, to use IP fragmentation, all ports in the VLAN must be configured for jumbo frame support.

**NOTE**

IP fragmentation within a VLAN does not apply to Summit X250e, X440, X450a, X450e, X460, X480, X650, and X670 series switches (whether or not included in a SummitStack), and BlackDiamond 8000 c-, e-, xl-, and xm-series, and BlackDiamond X8 modules. The platforms that currently support fragmentation do so only for layer-3 forwarding.

Link Aggregation on the Switch

The link aggregation (also known as load sharing) feature allows you to increase bandwidth and availability by using a group of ports to carry traffic in parallel between switches. Load sharing, link aggregation, and trunking are terms that have been used interchangeably in Extreme Networks documentation to refer to the same feature, which allows multiple physical ports to be aggregated into one logical port, or link aggregation group (LAG). Refer to IEEE 802.3ad for more information on this feature. The advantages to link aggregation include an increase in bandwidth and link redundancy.

This section describes the following topics:

- [Link Aggregation Overview on page 284](#)
- [Link Aggregation and Software-Controlled Redundant Ports on page 285](#)
- [Dynamic Versus Static Load Sharing on page 285](#)
- [Load-Sharing Algorithms on page 285](#)
- [LACP on page 288](#)
- [Health Check Link Aggregation on page 291](#)
- [Guidelines for Load Sharing on page 292](#)
- [Configuring Switch Load Sharing on page 294](#)
- [Load-Sharing Examples on page 297](#)
- [Displaying Switch Load Sharing on page 298](#)

Link Aggregation Overview



NOTE

All ports in a LAG must be running at the same speed and duplex setting. Each port can belong to only one LAG.

Load sharing allows the switch to use multiple ports as a single logical port, or LAG. For example, VLANs see the LAG as a single logical port. And, although you can only *reference* the master port of a LAG to a Spanning Tree Domain (STPD), *all* the ports of the LAG actually belong to the specified STPD. Most load-sharing algorithms guarantee packet sequencing between clients.

Link aggregation, or load sharing, is disabled by default.

If a port in a load-sharing group (or LAG) fails, traffic is redistributed to the remaining ports in the LAG. If the failed port becomes active again, traffic is redistributed to include that port.



NOTE

Load sharing must be enabled on both ends of the link, or a network loop may result.

Link aggregation is most useful when:

- The egress bandwidth of traffic exceeds the capacity of a single link.
- Multiple links are used for network resiliency.

In both situations, the aggregation of separate physical links into a single logical link multiplies total link bandwidth in addition to providing resiliency against individual link failures.

In modular switches, ExtremeXOS supports LAGs across multiple modules, so resiliency is also provided against individual module failures.

The software supports control protocols across the LAGs, both static and dynamic. If you add the protocols (for example, EAPS, ESRP, and so forth) to the port and then create a LAG on that port, you may experience a slight interruption in the protocol operation. To seamlessly add or delete bandwidth when running control protocols, Extreme Networks recommends that you create a LAG consisting of only one port. Then add your protocols to that port and add other ports as needed.

VMAN ports can belong to LAGs. You must enable jumbo frames on BlackDiamond 8800 series switches, SummitStack, and Summit family switches. Also, VMAN is automatically enabled on all ports of an untagged LAG.



NOTE

You can use VMAN ACLs to configure load sharing on a VMAN. See [Chapter 18, “ACLs,”](#) for complete information on VMAN ACLs.

You can run the Link Layer Discovery Protocol (LLDP) on ports in a LAG.

Link Aggregation and Software-Controlled Redundant Ports

Summit Family Switches Only.

If you are configuring software-controlled redundant ports and link aggregation together, the following rules apply:

- You must unconfigure the software-controlled redundant ports *before* either configuring or unconfiguring load sharing.
- The entire LAG must go down before the software-controlled redundant port takes effect.

Dynamic Versus Static Load Sharing

ExtremeXOS software supports two broad categories of load sharing, or link aggregation:

- **Dynamic load sharing**—Dynamic load sharing includes the Link Aggregation Control Protocol (LACP) and Health Check Link Aggregation. The Link Aggregation Control Protocol is used to dynamically determine if link aggregation is possible and then to automatically configure the aggregation. LACP is part of the IEEE 802.3ad standard and allows the switch to dynamically reconfigure the link aggregation groups (LAGs). The LAG is enabled only when LACP detects that the remote device is also using LACP and is able to join the LAG. Health Check Link Aggregation is used to create a link aggregation group that monitors a particular TCP/IP address and TCP port.
- **Static load sharing**—Static load sharing is a grouping of ports specifically configured to load share. The switch ports at each end must be specifically configured as part of a load-sharing group.



NOTE

The platform-related load-sharing algorithms apply to LACP (as well as static load sharing).

Load-Sharing Algorithms

Load-sharing, or link aggregation, algorithms select an egress link for each packet forwarded to egress LAG. The ExtremeXOS software supports the following types of load sharing algorithms:

- **Port based**—The egress link is chosen based on the ingress port number.
- **Address based**—The egress link is chosen based on egress packet contents.

The ExtremeXOS software provides multiple addressed-based algorithms. For some types of traffic, the algorithm is fixed and cannot be changed. For other types of traffic, you can configure an algorithm. Algorithm selection is not intended for use in predictive traffic engineering.

The following sections describe the algorithm choices for different platforms:

- [Link Aggregation Algorithms—Summit X150, X250e, X350, X450a, and X450e Series Switches on page 286](#)
- [Link Aggregation Algorithms—BlackDiamond X8, BlackDiamond 8500 and 8800 Series Modules and SummitStack on page 286](#)
- [Link Aggregation Algorithms—BlackDiamond X8 Series Switches, BlackDiamond 8900 Series Modules, SummitStack, and Summit X440, X460, X480, X650, and X670 Series Switches on page 287](#)

**NOTE**

Always reference the master logical port of the load-sharing group when configuring or viewing VLANs. VLANs configured to use other ports in the LAG will have those ports deleted from the VLAN when link aggregation is enabled.

Link Aggregation Algorithms—Summit X150, X250e, X350, X450a, and X450e Series Switches

Summit X150, X250e, X350, X450a, and X450e series switches and SummitStack support address-based load sharing. (These platforms do not support port-based load sharing.) The following are the types of traffic to which address-based algorithms apply and the traffic components used to select egress links:

- Layer 2 frames and non-IP traffic—The source and destination MAC addresses.
- IPv4 and IPv6 packets—When a Summit X650 switch is not present in a SummitStack, load sharing is based on the configured options supported on each platform:
 - L2 algorithm—Layer 2 source and destination MAC addresses. Available on SummitStack and all Summit family switches.
 - L3_L4 algorithm—Layer 3 and Layer 4, the combined source and destination IP addresses and source and destination TCP and UDP port numbers. Available on SummitStack and Summit X250e, X450a, X450e, and X650 series switches.
- IPv4 and IPv6 packets—When Summit X650 switches are installed in a SummitStack, load sharing on all other switch types is based on the switch type:
 - All SummitStack compatible Summit family switches: Layer 3 and Layer 4, the combined source and destination IP addresses and source and destination TCP and UDP port numbers.
- Broadcast, multicast, and unknown unicast packets (not configurable)—Depends on traffic type:
 - IPv4 and IPv6 packets—The source and destination IP addresses.
 - Non-IP traffic—The source and destination MAC addresses.

You control the field examined by the switch for address-based load sharing when the load-sharing group is created by using the following command:

```
enable sharing <port> grouping <port_list> {algorithm [address-based {L2 | L3 | L3_L4 | custom}] } {lacp | health-check}
```

**NOTE**

The L3 and custom keywords are not supported on Summit X150, X250e, X350, X450a, and X450e series switches. The L3_L4 keyword is not supported on Summit X150 and X350 series switches.

Link Aggregation Algorithms—BlackDiamond X8, BlackDiamond 8500 and 8800 Series Modules and SummitStack

BlackDiamond X8 series switches, BlackDiamond 8500 and 8800 series modules and SummitStack support address-based load sharing. (These platforms do not support port-based load sharing.) BlackDiamond 8000 a-, c-, and e-series modules distribute packets across all members of a LAG.

The following are the types of traffic to which address-based algorithms apply and the traffic components used to select egress links:

- IPv4 and IPv6 packets—When no BlackDiamond 8900 series modules or Summit X650 switches are installed in a modular switch or SummitStack, load sharing is based on the configured options supported on each platform:
 - L2 algorithm—Layer 2 source and destination MAC addresses. Available on BlackDiamond 8800 series switches, SummitStack, and all Summit family switches.
 - L3 algorithm—Layer 3 source and destination IP addresses. Available on BlackDiamond 8800 series switches and SummitStack.
 - L3_L4 algorithm—Layer 3 and Layer 4, the combined source and destination IP addresses and source and destination TCP and UDP port numbers. Available on BlackDiamond 8000 a-, c-, and e-series modules and BlackDiamond 8500 series modules.
- IPv4 and IPv6 packets—When BlackDiamond 8900 series modules are installed in a BlackDiamond 8800 series switch or when Summit X650 switches are installed in a SummitStack, load sharing on all other module or switch types is based on the combined source and destination IP addresses and source and destination TCP and UDP port numbers.
- Non-IP traffic—The source and destination MAC addresses.

You control the field examined by the switch for address-based load sharing when the load-sharing group is created by using the following command:

```
enable sharing <port> grouping <port_list> {algorithm [address-based {L2 | L3 | L3_L4 | custom}] } {lacp | health-check}
```

Link Aggregation Algorithms—BlackDiamond X8 Series Switches, BlackDiamond 8900 Series Modules, SummitStack, and Summit X440, X460, X480, X650, and X670 Series Switches

BlackDiamond X8 series switches, BlackDiamond 8900 series modules, SummitStack, and Summit X440, X460, X480, X650, and X670 series switches support address-based load sharing. (These platforms do not support port-based load sharing.) These platforms support two types of algorithms:

- Standard algorithms, which are supported by other switch platforms too.
- Custom algorithms, which use newer switch hardware to offer additional options, including the ability to evaluate IP address information from the inner header of an IP-in-IP or GRE tunnel packet.

Standard Algorithms. The following are the types of traffic to which standard address-based algorithms apply and the traffic components used to select egress links:

- Layer 2 frames and non-IP traffic—The source and destination MAC addresses.
- IPv4 and IPv6 packets—Load sharing is based on the configured options supported on each platform:
 - L2 algorithm—Layer 2 source and destination MAC addresses.
 - L3 algorithm—Layer 3 source and destination IP addresses.
 - L3_L4 algorithm—Layer 3 and Layer 4, the combined source and destination IP addresses and source and destination TCP and UDP port numbers.
- MPLS packets—The source and destination MAC addresses.

Custom Algorithms. The following are the types of traffic to which custom address-based algorithms apply and the traffic components used to select egress links:

- Non-IP Layer 2—Uses the VLAN ID, the source and destination MAC addresses, and the ethertype.
- IPv4 packets—Uses IP address information from an IP header, or for tunneled packets, the custom algorithm always uses the inner header of an IP-in-IP or GRE tunnel packet. The configuration options are:
 - The source and destination IPv4 addresses and Layer 4 port numbers (default)
 - The source IP address only,
 - The destination IP address only
 - The source and destination IP addresses
- IPv6 packets—Uses the source and destination IPv6 addresses and Layer 4 port numbers.
- MPLS packets—Uses the top, second, and reserved labels and the source and destination IP addresses.

The following command allows you to enable load sharing and select either a standard algorithm or specify that you want to use a custom algorithm:

```
enable sharing <port> grouping <port_list> {algorithm [address-based {L2 | L3 | L3_L4 | custom}]} {lacp | health-check}
```

If you choose the `custom` option when you enable load sharing, you can use the following command to select a custom load sharing algorithm:

```
configure sharing address-based custom [ipv4 [L3-and-L4 | source-only | destination-only | source-and-destination] | hash-algorithm [xor | crc-16]]
```

The `hash-algorithm` option controls how the source information (such as an IP address) is used to select the egress port. The `xor` hash algorithm guarantees that the same egress port is selected for traffic distribution based on a pair of IP addresses, Layer 4 ports, or both, regardless of which is the source and which is the destination.



NOTE

Use of the ACL `redirect-port-no-sharing <port>` action overrides any load-sharing algorithm hash that is generated based on the lookup results. For more information on this action, see “LAG Port Selection” on page 710 in the ACL chapter.

LACP



NOTE

LACP fails over hitlessly in the event of a failover to a duplicate MSM/MM in a modular switch.

You can run the Link Aggregation Control Protocol (LACP) on Extreme Networks devices. LACP enables dynamic load sharing and hot standby for link aggregation links, in accordance with the IEEE 802.3ad standard. All third-party devices supporting LACP run with Extreme Networks devices.

The addition of LACP provides the following enhancements to static load sharing, or link aggregation:

- Automatic configuration
- Rapid configuration and reconfiguration
- Deterministic behavior
- Low risk of duplication or misordering

After you enable load-sharing, the LACP protocol is enabled by default. You configure dynamic link aggregation by first assigning a primary, or logical, port to the group, or LAG and then specifying the other ports you want in the LAG.

LACP, using an automatically generated key, determines which links can aggregate. Each link can belong to only *one* LAG. LACP determines which links are available. The communicating systems negotiate priority for controlling the actions of the entire trunk (LAG), using LACP, based on the lowest system MAC number. You can override this automatic prioritization by configuring the system priority for each LAG.

After you enable and configure LACP, the system sends PDUs (LACPDUs) on the LAG ports. The LACPDUs inform the remote system of the identity of the sending system, the automatically generated key of the link, and the desired aggregation capabilities of the link. If a key from a particular system on a given link matches a key from that system on another link, those links are aggregatable. After the remote system exchanges LACPDUs with the LAG, the system determines the status of the ports and whether to send traffic on which ports.

Among those ports deemed aggregatable by LACP, the system uses those ports with the lowest port number as active ports; the remaining ports aggregatable to that LAG are put into standby status. Should an active link fail, the standby ports become active, also according to the lowest port number. (See [“Configuring LACP” on page 295](#) for the number of active and standby LACP links supported per platform.)

All ports configured in a LAG begin in an *unselected* state. Based on the LACPDUs exchanged with the remote link, those ports that have a matching key are moved into a *selected* state. If there is no matching key, the ports in the LAG remain in the *unselected* state.

However if more ports in the LAG are selected than the aggregator can handle because of the system hardware, those ports that fall out of the hardware’s capability are moved into *standby* state. The lowest numbered ports are the first to be automatically added to the aggregator; the rest go to standby. As the name implies, these ports are available to join the aggregator if one of the *selected* ports should go offline.

You can configure the port priority to ensure the order that ports join the aggregator. However, that port must first be added to the LAG before you can configure the LACP settings. Again, if more than one port is configured with the same priority, the lowest-numbered port joins the aggregator first.

After the ports in the LAG move into the *selected* state, LACP uses the *mux* portion of the protocol to determine which ports join the aggregator and can collect and distribute traffic. A few seconds after a port is *selected*, it moves into the mux state of *waiting*, and then into the mux state of *attached*. The attached ports then send their own LACP sync messages announcing that they are ready to receive traffic.

The protocol keeps sending and receiving LACPDUs until both sides of the link have echoed back each other’s information; the ends of the link are then considered synchronized. After the sync messages match up on each end, that port is moved into the aggregator (into the mux state of *collecting-distributing*) and is able to collect and distribute traffic.

The protocol then enables the aggregated link for traffic and monitors the status of the links for changes that may require reconfiguration. For example, if one of the links in a LAG goes down and there are standby links in that LAG, LACP automatically moves the standby port into selected mode and that port begins collecting and distributing traffic.

The marker protocol portion of LACP ensures that all traffic on a link has been received in the order in which it was sent and is used when links must be dynamically moved between aggregation groups. The Extreme Networks LACP implementation responds to marker frames but does not initiate these frames.

**NOTE**

Always verify the LACP configuration by issuing the `show ports sharing` command; look for the ports specified as being in the aggregator. You can also display the aggregator count by issuing the `show lacp lag` command.

You can configure additional parameters for the LACP protocol and the system sends certain SNMP traps in conjunction with LACP. The system sends a trap when a member port is added to or deleted from an aggregator.

The system now detects and blocks loopbacks; that is, the system does not allow a pair of ports that are in the same LAG but are connected to one another by the same link to select the same aggregator. If a loopback condition exists between two ports, they cannot aggregate. Ports with the *same* MAC address *and* the *same* admin key cannot aggregate; ports with the *same* MAC address and a *different* admin key can belong to the same LAG.

The system sends an error message if a LAG port is configured and up but still not attached to the aggregator or in operation within 60 seconds. Use the `show lacp member-port <port> detail` command to display the churn on both sides of the link. If the Churn value is shown as True in the display, check your LACP configuration. The issue may be either on your end or on the partner link, but you should check your configuration. The display shows as True until the aggregator forms, when it changes to display as False.

A LAG port moves to expired and then to the defaulted state when it fails to receive an LACPDU from its partner for a specified time. You can configure this timeout value as long, which is 90 seconds, or short, which is 3 seconds; the default is long. (In ExtremeXOS 11.3, the timeout value is not configurable and is set as long, or 90 seconds.) Use the `show lacp lag <group-id> detail` command to display the timeout value for the LAG.

There are two LACP activity modes: active and passive. In LACP active mode, the switch periodically sends LACPDUs; in passive mode, the switch sends LACPDUs only when it receives one from the other end of the link. The default is active mode. (In ExtremeXOS 11.3, the mode is not configurable; it is always active mode.) Use the `show lacp lag <group-id> detail` command to display the LACP mode for the LAG.

**NOTE**

One side of the link must be in active mode in order to pass traffic. If you configure your side in the passive mode, ensure that the partner link is in LACP active mode.

A LAG port moves into a defaulted state after the timeout value expires with no LACPDUs received for the other side of the link. You can configure whether you want this defaulted LAG port removed from the aggregator or added back into the aggregator. If you configure the LAG to remove ports that move

into the default state, those ports are removed from the aggregator and the port state is set to unselected. The default configuration for defaulted ports is to be removed, or deleted, from the aggregator. (In ExtremeXOS version 11.3, defaulted ports in the LAG are always removed from the aggregator; this is not configurable.)

**NOTE**

To force the LACP trunk to behave like a static sharing trunk, use the `configure sharing lacp defaulted-state-action` command to add ports to the aggregator.

If you configure the LAG to add the defaulted port into the aggregator, the system takes inventory of the number of ports currently in the aggregator. If there are fewer ports in the aggregator than the maximum number allowed, the system adds the defaulted port to the aggregator (port set to selected and collecting-distributing). If the aggregator has the maximum ports, the system adds the defaulted port to the standby list (port set to standby). Use the `show lacp lag <group-id> {detail}` command to display the defaulted action set for the LAG.

**NOTE**

If the defaulted port is assigned to standby, that port automatically has a lower priority than any other port in the LAG (including those already in standby).

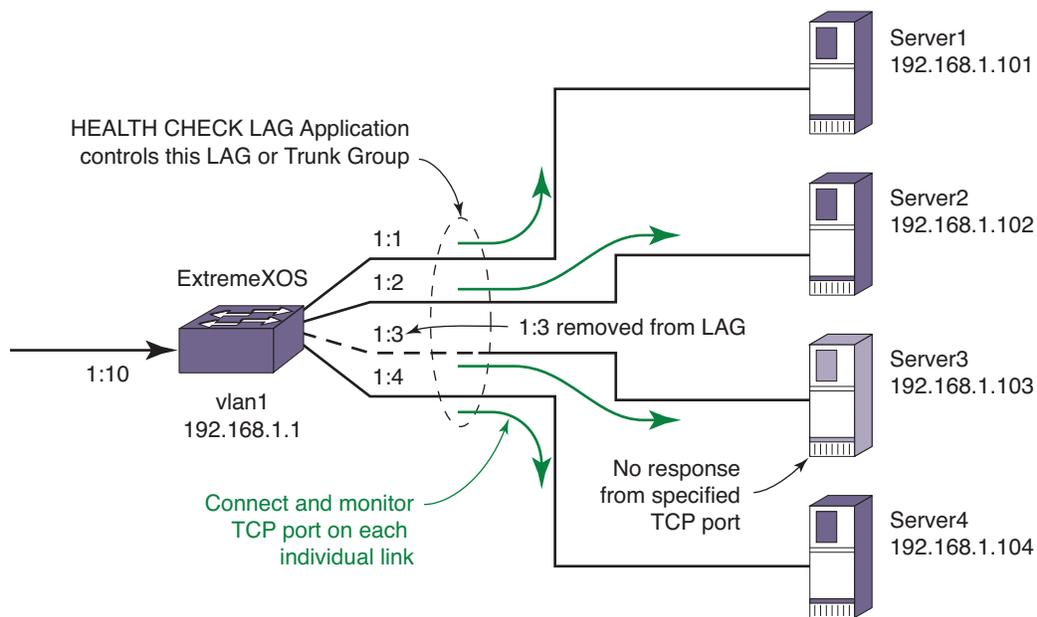
Health Check Link Aggregation

The Health Check LAG application allows you to create a link aggregation group where individual member links can monitor a particular TCP/IP address and TCP port. When connectivity to the TCP/IP address and TCP port fails, the member link is removed from the link aggregation group.

Establishing the status of a TCP connectivity is based on standard TCP socket connections. As long as the switch can establish a TCP connection to the target switch and TCP port, the connection is considered up. The TCP connection will retry based on the configured frequency and miss settings.

A typical use case for this application is when a user wishes to connect each member link to a Security Server to validate traffic. Each member link of the Health Check LAG is connected to an individual Security Server. The LAG is added to a VLAN on the same subnet as the Security Server IP addresses they wish to monitor. Each member port is configured to monitor a particular IP address and TCP port. The Health Check LAG application attempts to do a TCP connect to each IP/TCP port through each member port. The Health Check LAG, by virtue of the sharing algorithm, will load balance traffic across the member links. If a TCP connection cannot be established through the member link, the port is removed from the aggregator and traffic through that particular link is redistributed to the other LAG member links.

Figure 33 displays an example of a Health Check LAG.

Figure 33: Health Check LAG Example

Note: The default port to monitor is port 80 (HTTP).

EX_Ports_0045

Guidelines for Load Sharing

The following sections provide guidelines for load sharing:

- [Load Sharing Guidelines for Summit Family Switches and SummitStack on page 292](#)
- [Load Sharing Guidelines for BlackDiamond X8 Series Switches and BlackDiamond 8800 Series Switches on page 293](#)
- [Load Sharing Rules and Restrictions for All Switches on page 294](#)

Load Sharing Guidelines for Summit Family Switches and SummitStack

The following rules apply to load sharing on Summit family switches:

- One static LAG can contain up to 8 ports.
- One LACP LAG can contain up to 16 links per LAG, which includes up to 8 selected links and 8 standby links.
- A Health Check LAG can contain up to 8 ports.
- You can configure only the address-based load-sharing algorithm as described in the following sections:
 - [Link Aggregation Algorithms—Summit X150, X250e, X350, X450a, and X450e Series Switches on page 286](#)
 - [Link Aggregation Algorithms—BlackDiamond X8, BlackDiamond 8500 and 8800 Series Modules and SummitStack on page 286](#)
 - [Link Aggregation Algorithms—BlackDiamond X8 Series Switches, BlackDiamond 8900 Series Modules, SummitStack, and Summit X440, X460, X480, X650, and X670 Series Switches on page 287](#)

- The maximum number of LAGs for Summit family switches is 128.

**NOTE**

See [“Configuring LACP” on page 295](#) for the maximum number of links, selected and standby, per LACP.

The limits on the number of ports per LAG are different for X670. The following rules apply to load sharing on the X670.

- A static LAG can contain up to 32 ports when configured to use the custom address-based algorithm. For all other algorithms, a static LAG can contain up to 16 ports.
- An LACP LAG configured to use the custom address-based algorithm can contain up to 64 ports per LAG, which includes up to 32 selected links and 32 standby links. For all other algorithms, an LACP LAG can contain up to 32 ports per LAG, which includes up to 16 selected links and 16 standby links.

**NOTE**

These limits for X670 do not apply to X670s in a stack. X670s in a stack have the same limits as for other Summits.

Load Sharing Guidelines for BlackDiamond X8 Series Switches and BlackDiamond 8800 Series Switches

The following rules apply to load sharing on BlackDiamond X8 series switches and BlackDiamond 8800 series switches:

- One static LAG can contain up to 8 ports.
- For the BlackDiamond X8, the maximum number of LAGs is 384.
- The limits on the BlackDiamond X8 are different from BlackDiamond 8800:
 - A static LAG can contain up to 64 ports.
 - An LACP LAG configured to use the custom address-based algorithm can contain up to 128 links per LAG, which includes up to 64 selected links and 64 standby links.
 - An LACP LAG configured to use an algorithm other than the custom address-based algorithm can contain up to 32 links per LAG, which includes up to 16 selected links and 16 standby links.
- One LACP LAG can contain up to 16 links per LAG, which includes up to 8 selected links and 8 standby links.
- One Health Check LAG can contain up to 8 ports.
- You can configure only the address-based load-sharing algorithm as described in the following sections:
 - [Link Aggregation Algorithms—BlackDiamond X8, BlackDiamond 8500 and 8800 Series Modules and SummitStack on page 286](#)
 - [Link Aggregation Algorithms—BlackDiamond X8 Series Switches, BlackDiamond 8900 Series Modules, SummitStack, and Summit X440, X460, X480, X650, and X670 Series Switches on page 287](#)

- The maximum number of LAGs is 128. See “[Configuring LACP](#)” on page 295 for the maximum number of links, selected and standby, per LACP.
-

Load Sharing Rules and Restrictions for All Switches

Additionally, the following rules apply to load sharing on *all* switches:

- The ports in the LAG do not need to be contiguous.
- A LAG that spans multiple modules must use ports that have the same maximum bandwidth capability, with one exception—you can mix media type on 1 Gbps ports.
- On both ingress and egress direction on BlackDiamond 8800 series switches and Summit family switches, when you configure an ACL to a LAG group, you must configure each of the member ports exclusively.

Configuring Switch Load Sharing



NOTE

See “[Guidelines for Load Sharing](#)” on page 292 for specific information on load sharing for each specific device.

To set up a switch for load sharing, or link aggregation, among ports, you must create a load-sharing group of ports, also known as a link aggregation group (LAG). The first port in the load-sharing group is configured to be the *master* logical port. This is the reference port used in configuration commands and serves as the LAG group ID. It can be thought of as the logical port representing the entire port group.

All the ports in a load-sharing group must have the same exact configuration, including autonegotiation, duplex setting, ESRP host attach or don’t-count, and so on. All the ports in a load-sharing group must also be of the same bandwidth class.

The following sections describe common load sharing configuration tasks:

- [Creating and Deleting Load Sharing Groups on page 294](#)
- [Adding and Deleting Ports in a Load-Sharing Group on page 295](#)
- [Configuring the Load Sharing Algorithm on page 295](#)
- [Configuring LACP on page 295](#)
- [Configuring Health Check Link Aggregation on page 296](#)

Creating and Deleting Load Sharing Groups

To define a load-sharing group, or LAG, you assign a group of ports to a single, logical port number. To enable or disable a load-sharing group, use the following commands:

```
enable sharing <port> grouping <port_list> {algorithm [address-based {L2 | L3 | L3_L4
| custom}}] {lacp | health-check}
disable sharing <port>
```

**NOTE**

All ports that are designated for the LAG must be removed from all VLANs prior to configuring the LAG.

Adding and Deleting Ports in a Load-Sharing Group

Ports can be added or deleted dynamically in a load-sharing group, or LAG. To add or delete ports from a load-sharing group, use the following commands:

```
configure sharing <port> add ports <port_list>
configure sharing <port> delete ports <port_list>
```

**NOTE**

See “Configuring LACP” on page 295 for the maximum number of links, selected and standby, per LACP.

Configuring the Load Sharing Algorithm

For some traffic on selected platforms, you can configure the load sharing algorithm as described in “Load-Sharing Algorithms” on page 285. The commands for configuring load sharing algorithms are:

```
enable sharing <port> grouping <port_list> {algorithm [address-based {L2 | L3 | L3_L4 | custom}] } {lacp | health-check} (SummitStack and all Summit family switches except Summit X650)
```

```
configure sharing address-based custom [ipv4 [L3-and-L4 | source-only | destination-only | source-and-destination] | hash-algorithm [xor | crc-16]] (BlackDiamond 8900 series modules, Summit X650 switches, and SummitStack)
```

Configuring LACP

**NOTE**

Extreme Networks does not recommend enabling LACP and ELSM on the same port. See [Chapter 11, “Status Monitoring and Statistics,”](#) for information on ELSM.

To configure LACP, you must, again, first create a LAG. The first port in the LAG serves as the logical port for the LAG. This is the reference port used in configuration commands. It can be thought of as the logical port representing the entire port group, and it serves as the LAG Group ID.

To create a LAG for LACP:

- 1 Create a LAG, using the following command:

```
enable sharing <port> grouping <port_list> {algorithm [address-based {L2 | L3 | L3_L4 | custom}] } {lacp | health-check}
```

The port you assign using the first parameter becomes the logical port for the link aggregation group and the LAG Group ID when using LACP. This logical port must also be included in the port list of the grouping itself.

- 2 If you want to override the default prioritization in LACP for a specified LAG, use the following command:

```
configure sharing <port> lacp system-priority <priority>
```

This step is optional; LACP handles prioritization using system MAC addresses.

- 3 Add or delete ports to the LAG as desired, using the following command:

```
configure sharing <port> add ports <port_list>
```

- 4 If you want to override the ports selection for joining the LAG by configuring a priority for a port within a LAG, issue the following command:

```
configure lacp member-port <port> priority <port_priority>
```

- 5 If you want to change the expiry timer, use the following command:

```
configure sharing <port> lacp timeout [long | short]
```

The default value for the timeout is long, or 90 seconds.

- 6 If you want to change the activity mode, use the following command:

```
configure sharing <port> lacp activity-mode [active | passive]
```

The default value for the activity mode is active.

- 7 If you want to configure the action the switch takes for defaulted LAG ports, use the following command:

```
configure sharing <port> lacp defaulted-state-action [add | delete]
```

The default value for defaulted LAG ports is delete the default ports.

**NOTE**

Always verify the LACP configuration by issuing the `show ports sharing` command; look for the ports listed as being in the aggregator.

Configuring Health Check Link Aggregation

To configure Health Check link aggregation you must first create a LAG. One port in the LAG serves as the logical port for the LAG and is the reference port used in configuration commands.

When you create the LAG, no monitoring is initially configured. The LAG is created in the same way that a static LAG is created and if no monitoring is ever created, this LAG behaves like a static LAG.

- 1 Create a LAG using the following command:

```
enable sharing <port> grouping <port_list> {algorithm [address-based {L2 | L3 | L3_L4 | custom}] } {lacp | health-check}
```

The port you assign using the `<port>` parameter becomes the logical port for the link aggregation group and the LAG Group ID when using Health Check link aggregation. This logical port must also be included in the port list of the grouping itself.

- 2 Configure monitoring for each member port using the following command:

```
configure sharing health-check member-port <port> add tcp-tracking <IP Address> {tcp-port <TCP Port> frequency <sec> misses <count>}
```

If the TCP-port, frequency, or misses are not specified, the defaults described in the *ExtremeXOS Command Reference Guide* are used.

- 3 Add the LAG to a VLAN whose subnet is the same as the configured tracking IP addresses.

```
configure vlan <vlan> add port <lag port> [tagged | untagged]
```

All of the tracking IP addresses must be in the same subnet in which the LAG belongs.



NOTE

VLANs to which Health Check LAG ports are to be added must be configured in loopback mode. This is to prevent the VLAN interface from going down if all ports are removed from the Health Check LAG. In a normal LAG when all ports are removed from the aggregator, the trunk is considered DOWN. As a consequence, if this were the only port in the VLAN, the VLAN interface would be brought DOWN as well. In the Health Check LAG situation, this would cause the TCP monitoring to fail because the L3 vlan interface used by TCP monitoring would no longer send or receive TCP data.

The following commands are used to modify the configured Health Check LAG.

- 1 Delete the monitoring configuration for a member port using the following command:

```
configure sharing health-check member-port <port> delete tcp-tracking <IP Address>
{tcp-port <TCP Port>}
```

- 2 Enable or disable monitoring for a member port in the Health Check LAG using the following command:

```
configure sharing health-check member-port <port> [disable | enable] tcp-tracking
```

Load-Sharing Examples

This section provides examples of how to define load sharing, or link aggregation, on stand-alone and modular switches, as well as defining dynamic link aggregation.

Load Sharing on a Stand-alone Switch

The following example defines a static load-sharing group that contains ports 9 through 12, and uses the first port in the group as the master logical port 9:

```
enable sharing 9 grouping 9-12
```

In this example, logical port 9 represents physical ports 9 through 12.

When using load sharing, you should always reference the master logical port of the load-sharing group (port 9 in the previous example) when configuring or viewing VLANs; the logical port serves as the LAG Group ID. VLANs configured to use other ports in the load-sharing group will have those ports deleted from the VLAN when load sharing becomes enabled.

Cross-Module Load Sharing on a Modular Switch or SummitStack

The following example defines a static load-sharing group on modular switches that contains ports 9 through 12 on slot 3, ports 7 through 10 on slot 5, and uses port 7 in the slot 5 group as the primary logical port, or LAG Group ID:

```
enable sharing 5:7 grouping 3:9-3:12, 5:7-5:10
```

In this example, logical port 5:7 represents physical ports 3:9 through 3:12 and 5:7 through 5:10.

When using load sharing, you should always reference the LAG Group ID of the load-sharing group (port 5:7 in the previous example) when configuring or viewing VLANs. VLANs configured to use other ports in the load-sharing group will have those ports deleted from the VLAN when load sharing becomes enabled.

Address-based load sharing can also span modules.

Single-Module Load Sharing on a Modular Switch or SummitStack

The following example defines a static load-sharing, or link aggregation, group that contains ports 9 through 12 on slot 3 and uses the first port as the master logical port 9, or LAG group ID:

```
enable sharing 3:9 grouping 3:9-3:12
```

In this example, logical port 3:9 represents physical ports 3:9 through 3:12.

LACP Example

The following configuration example:

- Creates a dynamic LAG with the logical port (LAG Group ID) of 10 that contains ports 10 through 12.
- Sets the system priority for that LAG to 3.
- Adds port 5 to the LAG.

```
enable sharing 10 grouping 10-12 lacp
configure sharing 10 lacp system-priority 3
configure sharing 10 add port 5
```

Health Check LAG Example

The following example creates a Health Check LAG of 4 ports:

```
create vlan v1
configure v1 ip 192.168.1.1/24
enable sharing 5 grouping 5-8 health-check
enable loopback-mode v1
configure v1 add port 5
configure sharing health-check member-port 5 add track-tcp 192.168.1.101 tcp-port 8080
configure sharing health-check member-port 6 add track-tcp 192.168.1.102 tcp-port 8080
configure sharing health-check member-port 7 add track-tcp 192.168.1.103 tcp-port 8080
configure sharing health-check member-port 8 add track-tcp 192.168.1.104 tcp-port 8080
```

Displaying Switch Load Sharing

You can display static and dynamic load sharing. In the link aggregation displays, the types are shown by the following aggregation controls:

- Static link aggregation—static
- Link Aggregation Control Protocol—LACP
- Health check link aggregation—hlth-chk

To verify your configuration, use the following command:

```
show ports sharing
```

To verify LACP configuration, use the following command:

```
show lacp
```

To display information for the specified LAG, use the following command:

```
show lacp lag <group-id> {detail}
```

To display LACP information for a port that is a member of a LAG, use the following command:

```
show lacp member-port <port> {detail}
```

Refer to “[Displaying Port Information](#)” for information on displaying summary load-sharing information.

To clear the counters, use the following command:

```
clear lacp counters
```

You can display the LACP counters for all member ports in the system. To display the LACP counters, use the following command:

```
show lacp counters
```

To display information for a health check LAG, use the following command:

```
show sharing health-check
```

MLAG

BlackDiamond X8 Series Switches, BlackDiamond 8000 Series Modules, Summit Family Switches, and SummitStack

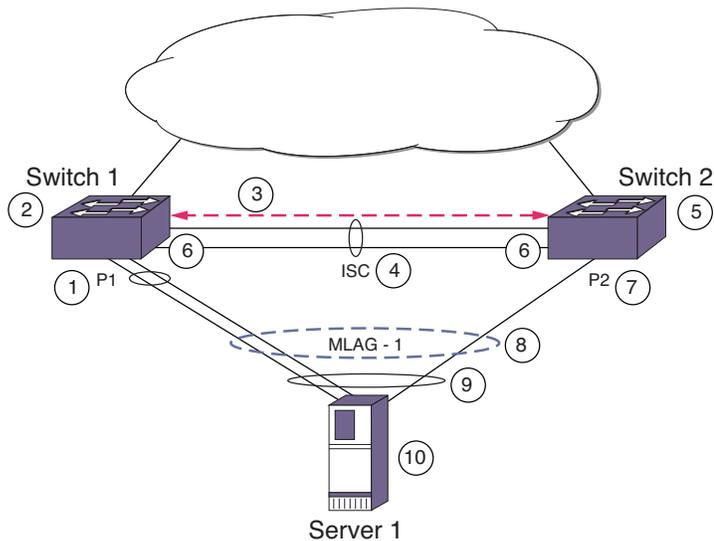
This section consists of the following topics:

- [Overview on page 299](#)
- [Limitations and Requirements on page 301](#)
- [Configuring MLAGs on page 304](#)
- [Example of MLAG Configuration on page 305](#)

Overview

The *multi-switch link aggregation group (MLAG)* feature allows you to combine ports on two switches to form a single logical connection to another network device. The other network device can be either a server or a switch that is separately configured with a regular LAG (or appropriate server port teaming) to form the port aggregation.

[Figure 34](#) displays the elements in a basic MLAG configuration.

Figure 34: MLAG Elements

- ① MLAG port that is a load-shared link. This port is the peer MLAG port for <Switch2:Port P2>.
- ② MLAG peer switch for Switch 2.
- ③ Inter-Switch Connection (ISC or ISC VLAN) has only the ISC port as a member port on both MLAG peers.
- ④ ISC Link that connects MLAG peers.
- ⑤ MLAG peer switch for Switch 1.
- ⑥ ISC ports
- ⑦ MLAG port that is a non-load-shared link. This port is the peer MLAG port for <Switch1:Port P1>.
- ⑧ MLAG group (MLAG-ID 1) that has 2 member ports (1 load-shared and 1 non-load-shared member).
- ⑨ MLAG remote node sees the MLAG ports as a regular load-shared link.
- ⑩ MLAG remote node - Can be a server or a switch.

EX_ports_0049

The basic operation of this feature requires two ExtremeXOS switches interconnected by an Inter-Switch connection (ISC). The ISC is a normal, directly connected, Ethernet connection and it is recommended that you engineer reliability, redundancy where applicable, and higher bandwidth for the ISC connection. Then you logically aggregate ports on each of the two switches by assigning MLAG identifiers (MLAG-ID). Ports with the same MLAG-ID are combined to form a single logical network connection. Each MLAG can be comprised of a single link or a LAG on each switch. When an MLAG port is a LAG, the MLAG port state remains up until all ports in the LAG go down. As long as at least one port in the LAG remains active, the MLAG port state remains active.

When an MLAG port (a single port or all ports in a LAG) fails, any associated MAC FDB entries are moved to the ISC, forcing traffic destined to the MLAG to be handled by the MLAG peer switch. Additionally, the MLAG peer switch is notified of the failure and changes its ISC blocking filter to allow transmission to the MLAG peer port. In order to reduce failure convergence time, you can configure MLAG to use ACLs for redirecting traffic via the "fast" convergence-control option.

**NOTE**

For Layer 3 unicast forwarding, you must configure VRRP or ESRP on the peer switches.

Each of the two switches maintains the MLAG state for each of the MLAG ports and communicates with each other to learn the MLAG states, MAC FDB, and IP multicast FDB of the peer MLAG switch.

ISC Blocking Filters

The ISC blocking filters are used to prevent looping and optimize bandwidth utilization. When at least one MLAG peer port is active, the upper layer software initiates a block of traffic that ingresses the ISC port and needs to be forwarded to the local MLAG ports. This is considered to be the steady state condition. In normal steady state operation most network traffic does not traverse the ISC. All unicast packets destined to MLAG ports are sent to the local MLAG port only. However, flood and multicast traffic will traverse the ISC but will be dropped from MLAG peer port transmission by the ISC blocking filter mechanism. The ISC blocking filter matches all Layer 2 traffic received on the ISC and blocks transmission to all MLAG ports that have MLAG peer ports in the active state.

When there are no active MLAG peer ports, the upper layer software initiates an unblocking of traffic that ingresses the ISC port and needs to be forwarded to the local MLAG ports thus providing redundancy. This is considered to be the failed state.

Inter-Switch Communication

Keep-alive Protocol. MLAG peers monitor the health of the ISC using a keep-alive protocol that periodically sends health-check messages. The frequency of these health-check hellos is configurable.

MLAG Status Checkpointing. Each switch sends its MLAG peer information about the configuration and status of MLAGs that are currently configured over the ISC link. This information is checkpointed over a TCP connection that is established between the MLAG peers after the keep-alive protocol has been bootstrapped.

PIM MLAG Support

ExtremeXOS allows you to configure PIM peers on an ISC link. This will help avoid using other links for PIM peers. ExtremeXOS supports the following PIM functionality for PIM-MLAG:

- The checkpoint PIM state between MLAG peers. This should include all MLAG egresses.

You can verify that PIM functionality for MLAG is present by issuing the following show command:

```
#show pim cache {{detail} | {state-refresh} {mlog-peer-info} {<group_addr>
{<source_addr>}}
```

Additionally, the existing `show pim cache` command displays ingress VLAN information for all MLAG peers. The output of the command is shown below:

```
Index  Dest Group      Source              InVlan  Origin
[0001] 225.0.0.1      64.1.1.100 (S)    vixia   Sparse
      Expires after 210 secs UpstNbr: 0.0.0.0
      [S1] Peer Ingress VLAN: 1.1.1.1/24 (Same)

      EgressIfList = v36(0) (FW) (DM) (I)
```

Limitations and Requirements

This feature has the following limitations:

- MLAG peer switches must be of the same platform family. The following MLAG peers are allowed: BlackDiamond 8800 switches with BlackDiamond 8800 switches, BlackDiamond X8 switches with BlackDiamond X8 switches, Summit switches with Summit switches, and SummitStack with SummitStack.

**NOTE**

In the case of Summit standalone switches, it is strongly recommended that MLAG peer switches be of the same type, for example, Summit X480 switches with Summit X480 switches.

In the case of SummitStack and BlackDiamond 8800 switches, we recommend that the MLAG ports be from slots of similar capability, for example, Summit X650-24x to Summit X650-24t switches and BlackDiamond 8900-G48X-xl to BlackDiamond 8900-G48T-xl modules.

- Only a single MLAG peer switch is allowed.
- Layer 2 protocols, such as EAPS or STP, will be configured to not allow the blocking of the ISC.
- The number of MLAGs for each pair of switches is limited to 768.

Table 31 shows additional MLAG requirements that are specific to other protocols and features.

Table 31: MLAG Requirements

Items	Impact
VLAN:Membership	You must add the respective port (or LAG) that is part of an MLAG to a VLAN on both MLAG peers. The set of configured VLANs on [Switch1:P1] must be identical to the set of VLANs configured on [Switch2:P2].
VLAN:ISC	You must add the ISC to every VLAN that has an MLAG link as a member port. The restrictions are the same as those for VLAN Membership.
VLAN:ISC	You must create a Layer 3 VLAN for control communication between MLAG peers. You cannot enable IP forwarding on this VLAN. The ISC is exclusively used for inter-MLAG peer control traffic and should not be provisioned to carry any user data traffic. Customer data traffic however can traverse the ISC port using other user VLANs.
VLAN:ISC	Although not recommended, a VMAN may be configured to carry Inter-MLAG peer traffic,
LAG:LACP	Not supported for LAGs that form an MLAG.
LAG:Load-Sharing Algorithm	It is recommended but not required that LAGs that form an MLAG be configured to use the same algorithm.
Ports:Flooding	To disable flooding on an MLAG you must disable flooding on both ports (or LAGs) that form the MLAG.
Ports:Learning	To disable learning on an MLAG you must disable learning on both ports (or LAGs) that form the MLAG. Learning is disabled by default on ISC ports.
FDB:Static & Blackhole entries	Configuration must be identical on both MLAG peers for entries that point to an MLAG port.
FDB:Limit learning	Learning limits are applicable to member ports of each peer. The limit on the MLAG is the sum of the configured value on each peer.
FDB:MAC Lockdown	This is supported but needs configuration on both peers. A switch can still receive checkpointed MAC addresses from its peer in the window between executing the lockdown command on both switches.
EAPS	MLAG ports cannot be configured to be EAPS ring ports. Configuration of the ISC port as an EAPS blocked port is disallowed.
STP	STP cannot be enabled on MLAG ports. You should ensure that the ISC port is never blocked by STP.
VRRP	VRRP must be enabled on Layer 3 VLANs that have MLAG member ports.

Table 31: MLAG Requirements (Continued)

Items	Impact
ESRP	ESRP must be enabled on Layer 3 VLANs that have MLAG member ports. MLAG and ISC ports must be added as ESRP host-attach ports.
EDP/LLDP	There are no restrictions but the remote end of the MLAG will display different neighbors for different ports in the same LAG.
ELSM	ELSM is not to be configured on MLAG ports at either end of an MLAG.
Software-Redundant ports	These are not to be configured on MLAG ports at either end of an MLAG.
Mirroring	Mirroring on local ports in an MLAG is supported. Mirroring of MLAG peer ports to a local port is not supported.
Routing Protocols	No routing protocol neighborship can be formed across an MLAG.
Multicast:IGMP	All timers related to IGMP must be identical on both the peers.
Multicast:PIM	PIM should be configured on both the MLAG peers, and the PIM timers must be identical. MLAG functionality must not be enabled on PIM Intermediate routers. It should be enabled only on Last Hop (LHR) and First Hop (FHR) routers. MLAG peer switches S1 and S2 perform Checkpoint PIM for S and G states. This should include all MLAG egresses. To avoid traffic drops due to asserts, do not include ISC port in MLAG egresses if the ingress VLAN includes ISC port, and both the peers have the same ingress for the S, G cache.
Multicast:MVR	MVR should be enabled on only one of the MLAG peer switches. MVR must not be enabled on MLAG VLANs.
Multicast:PIM Snooping	This is not supported.
Multicast:IPv6	There are no restrictions.
CFM	There are no restrictions.
MPLS:General	MPLS cannot be enabled on VLANs having MLAG member ports.
MPLS:VPLS	VPLS must be configured for redundancy using ESRP. The ESRP master VLAN must include the ISC ports and the VPLS service VLAN ports as members. Pseudowires cannot traverse an ISC link. You should not add the ISC port as a member to MPLS VLANs that can be used by LSPs that can carry Layer 2 VPN traffic terminating on MLAG peer switches.
ACLs	It is strongly recommended that configuration be identical across peers on MLAG ports.
QoS	It is strongly recommended that configuration be identical across peers on MLAG ports.
Netlogin	This is not supported.
VLAN:PVLAN	If an MLAG port is a member of either a subscriber VLAN or a network VLAN, the ISC port needs to be added as a member of the network VLAN. Subscriber VLANs in a private VLAN cannot have overlapping MLAG ports as members. Configuring dedicated loopback ports for subscriber VLANs in a private VLAN that shares an MLAG port causes duplicate traffic to be sent to the remote node.
L3:IPv6	Routing of IPv6 over an MLAG is not supported in this release. IPv6 traffic needs to be tunneled using 6in4 or 6to4 tunnels.
DAD	DAD detects duplicate IPv4 addresses configured on a VLAN that spans MLAG peer switches. This occurs only when the solicitation attempts that use the configure ip dad attempts <max_solicitations> command is more than 1.

Configuring MLAGs

This section describes the commands used to configure MLAGs and display information about those configured.

To create an MLAG peer switch association structure, use the following command:

```
create mlag peer <peer_name>
```

To delete a peer switch, use the following command:

```
delete mlag peer <peer_name>
```

To associate an MLAG peer structure with an MLAG peer switch IP address, use the following command:

```
configure mlag peer <peer_name> ipaddress <peer_ip_address> {vr <VR>}
```

To unconfigure the association, use the following command:

```
unconfigure mlag peer <peer_name> ipaddress
```

To configure the time interval between health check hello packets exchanged between MLAG peer switches, use the following command:

```
configure mlag peer <peer_name> interval <msec>
```

To unconfigure the time interval setting and reset the interval to the default of 1000ms, use the following command:

```
unconfigure mlag peer <peer_name> interval
```

To bind a local port or LAG to an MLAG specified with an integer identifier, use the following command:

```
enable mlag port <port> peer <peer_name> id <identifier>
```

To disable a local port or LAG from an MLAG, use the following command:

```
disable mlag port <port>
```

To set a preference for having a fast convergence time or conserving access lists, use the following command:

```
configure mlag ports convergence-control [conserve-access-lists | fast]
```



NOTE

Executing the *refresh policy* command with MLAG configuration may result in health check hellos not reaching the CPU. To avoid MLAG peer connectivity disruption, you can either execute the *disable access-list refresh blackhole* command or temporarily increase the peer hello interval to a large value (for instance, 10000 ms) and reset it back once refresh policy is complete.

Displaying Information

To display information about an MLAG peer, including MLAG peer switch state, MLAG group count, and health-check statistics, use the following command:

```
show mlag peer {<peer_name>}
```

To display each MLAG group, including local port number, local port status, remote MLAG port state, MLAG peer name, MLAG peer status, local port failure count, remote MLAG port failure count, and MLAG peer failure count, use the following command:

```
show mlag ports {<portlist>}
```

To see if a port is part of an MLAG group or an ISC port, use the following command:

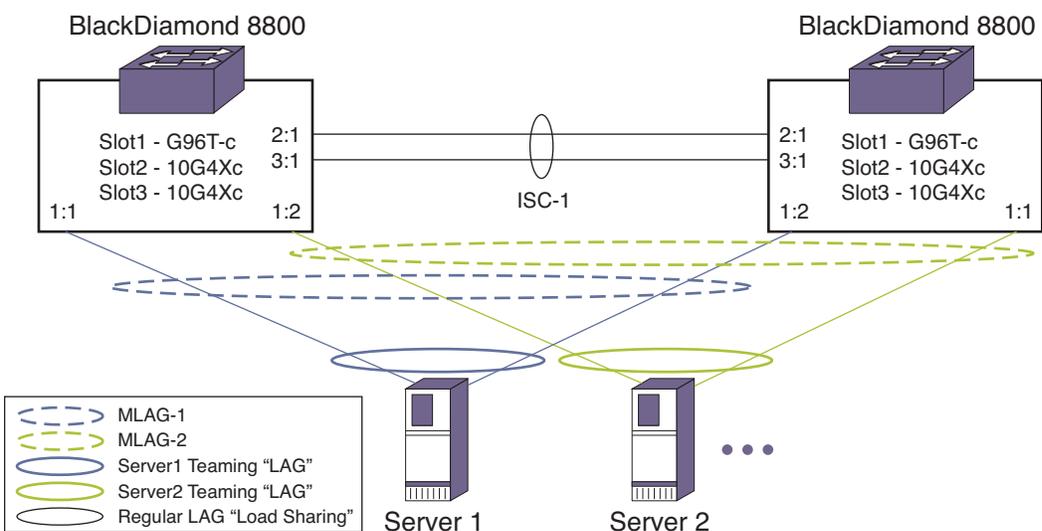
```
show ports information detail
```

Example of MLAG Configuration

This topic provides an example of how to configure an MLAG.

Figure 35 shows a finished MLAG network.

Figure 35: Simple MLAG Configuration



EX_ports_0050

To configure this MLAG, use the following procedure:

1 Create the Inter-Switch Connection (ISC)

Description: The ISC provides an out-of-band IP communications path between the 2 MLAG peer switches to exchange keep-alive packets and to checkpoint various state information between switches.

On the "Left" BlackDiamond 8800 switch:

```
enable sharing 2:1 group 2:1,3:1
create vlan isc
config vlan isc tag 3000
config vlan isc add port 2:1 tag
config vlan isc ipaddress 1.1.1.1/24
```

On the "Right" BlackDiamond 8800 switch:

```
enable sharing 2:1 group 2:1,3:1
create vlan isc
config vlan isc tag 3000
config vlan isc add port 2:1 tag
```

```
config vlan isc ipaddress 1.1.1.2/24
```

2 Create the MLAG peer and associate the peer switch's IP address

Description: By creating an MLAG peer you associate a peer name that can be associated with the peer switch's IP address and other peer configuration properties. The peer is then bound to each individual MLAG port group.

On the "Left" BlackDiamond 8800 switch:

```
create mlag peer "rightBD8K"
config mlag peer "rightBD8K" ipaddress 1.1.1.2
```

On the "Right" BlackDiamond 8800 switch:

```
create mlag peer "leftBD8K"
config mlag peer "leftBD8K" ipaddress 1.1.1.1
```

3 Create the MLAG port groups

Description: Creates an MLAG port group by specifying the local switch's port, the MLAG peer switch, and an "mlag-id" which is used to reference the corresponding port on the MLAG peer switch. The specified local switch's port can be either a single port or a load share master port.

On the "Left" BlackDiamond 8800 switch:

```
enable mlag port 1:1 peer "rightBD8K" id 1
enable mlag port 1:2 peer "rightBD8K" id 2
```

On the "Right" BlackDiamond 8800 switch:

```
enable mlag port 1:2 peer "leftBD8K" id 1
enable mlag port 1:1 peer "leftBD8K" id 2
```

4 Verify MLAG peers and ports are operational

Description: After MLAG groups are configured, you can verify the connections via the `show mlag peer` and `show mlag ports` commands. Be sure to note the peer status, the Local Link State, and the Remote Link status.

On the "Left" BlackDiamond 8800 switch:

```
BD-8810.5 # show mlag peer
Multi-switch Link Aggregation Peers:
```

```
MLAG Peer      : leftBD8k
VLAN           : isc
Local IP Address : 1.1.1.2
MLAG ports     : 2
Checkpoint Status : Up
Rx-Hellos      : 184
Tx-Checkpoints : 12
Rx-Hello Errors : 0
Hello Timeouts : 1
Up Time        : 0d:0h:0m:10s
Virtual Router  : VR-Default
Peer IP Address : 1.1.1.1
Tx-Interval    : 1000 ms
Peer Tx-Interval : 1000 ms
Tx-Hellos      : 184
Tx-Checkpoints : 12
Tx-Hello Errors : 0
Checkpoint Errors : 0
Peer Conn.Failures : 1
```

```
BD-8810.3 # show mlag ports
```

MLAG Id	Local Port	Local Link State	Remote Link	Peer	Peer Status	Local Fail Count	Remote Fail Count
1	1:1	A	Up	rightBD8K	Up	0	0
2	1:2	A	Up	rightBD8K	Up	0	0

Local Link State: A - Active, D - Disabled, R - Ready, NP - Port not present

```
Remote Link      : Up - One or more links are active on the remote switch,
                  Down - No links are active on the remote switch,
                  N/A - The peer has not communicated link state for this MLAG
                  port
```

```
Number of Multi-switch Link Aggregation Groups : 2
Convergence control                           : Fast
```

On the "Right" BlackDiamond 8800 switch:

```
BD-8810.3 # show mlag peer
Multi-switch Link Aggregation Peers:
```

```
MLAG Peer       : rightBD8k
VLAN            : isc          Virtual Router    : VR-Default
Local IP Address : 1.1.1.1     Peer IP Address  : 1.1.1.2
MLAG ports      : 2           Tx-Interval     : 1000 ms
Checkpoint Status : Up        Peer Tx-Interval : 1000 ms
Rx-Hellos       : 167        Tx-Hellos       : 167
Rx-Checkpoint Msgs: 12       Tx-Checkpoint Msgs: 12
Rx-Hello Errors  : 0         Tx-Hello Errors  : 0
Hello Timeouts   : 1         Checkpoint Errors : 0
Up Time          : 0d:0h:0m:7s Peer Conn.Failures: 1
```

```
BD-8810.5 # show mlag ports
```

MLAG Id	Local Port	Local Link State	Remote Link	Peer	Peer Status	Local Fail Count	Remote Fail Count
2	1:1	A	Up	leftBD8K	Up	0	0
1	1:2	A	Up	leftBD8K	Up	0	0

```
Local Link State: A - Active, D - Disabled, R - Ready, NP - Port not present
```

```
Remote Link      : Up - One or more links are active on the remote switch,
                  Down - No links are active on the remote switch,
                  N/A - The peer has not communicated link state for this MLAG
                  port
```

```
Number of Multi-switch Link Aggregation Groups : 2
Convergence control                           : Fast
```

5 Add ISC port to VLAN

Description: The ISC port must be added as a member port for any VLAN that has MLAG member ports.

```
create vlan "xyz"
```

On the "Left" BlackDiamond 8800 switch:

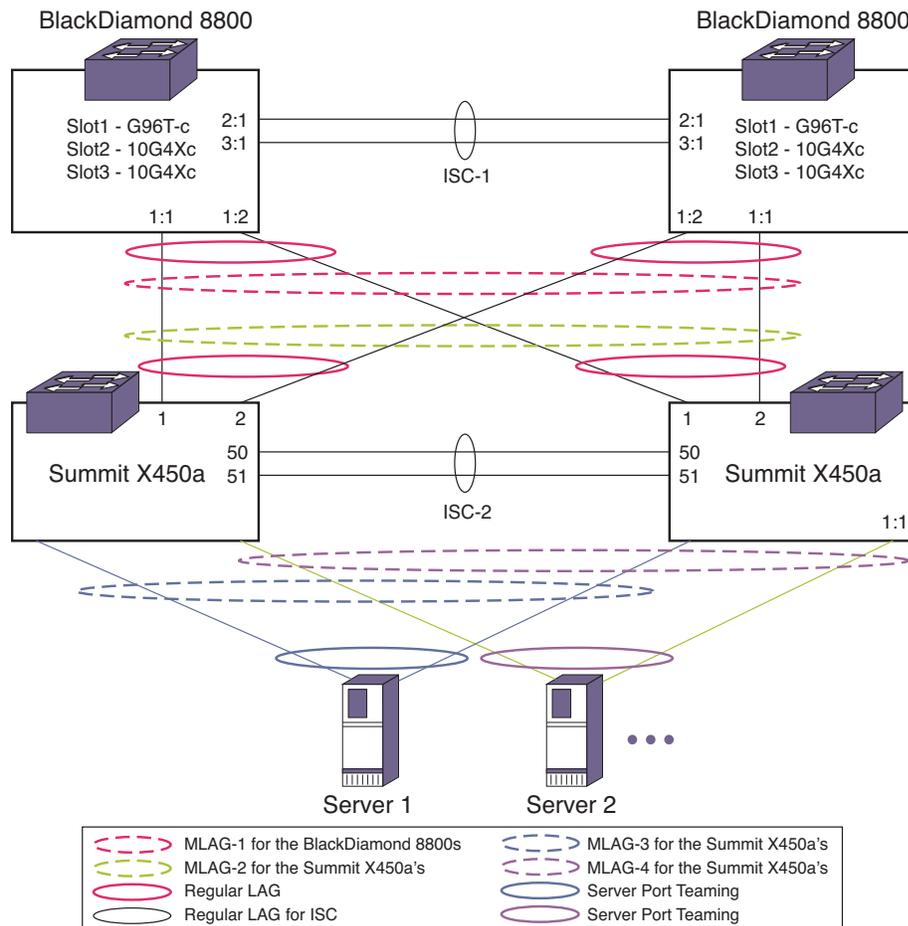
```
configure vlan "xyz" add port 1:1, 2:1 tagged
```

On the "Right" BlackDiamond 8800 switch:

```
configure vlan "xyz" add port 1:2, 2:1 tagged
```

Figure 35, the example above, shows a basic MLAG network. Figure 36 shows a network with back-to-back aggregation. There is one MLAG configured on the BlackDiamond switches and three configured on the Summit switches.

Figure 36: Two-tier MLAG Network



Mirroring



NOTE

You can accomplish port mirroring using ACLs or CLEAR-Flow. See [Chapter 18, "ACLs,"](#) for more information on ACLs and [Chapter 24, "CLEAR-Flow,"](#) for more information on CLEAR-Flow.

Mirroring configures the switch to copy all traffic associated with one or more ports, VLANs, or virtual ports. A virtual port is a combination of a VLAN and a port. The monitor port or ports can then be connected to a network analyzer or RMON probe for packet analysis. The system uses a traffic filter that copies a group of traffic to the monitor port(s). You can have only one monitor port or port list on the switch. This feature allows you to mirror multiple ports or VLANs to a monitor port, while preserving the ability of a single protocol analyzer to track and differentiate traffic within a broadcast domain (VLAN) and across broadcast domains (for example, across VLANs when routing).

**NOTE**

The mirroring filter limits discussed in this chapter do not apply when you are working with Sentriant devices.

Up to 128 mirroring filters can be configured with the restriction that a maximum of 16 of these can be configured as VLAN and/or virtual port (port + VLAN) filters.

One monitor port or 1 monitor port list can be configured. A monitor port list may contain up to 16 ports.

**NOTE**

On BlackDiamond X8 series switches, BlackDiamond 8800 series switches, SummitStack, and Summit family switches, you can mirror up to 16 VLANs.

Mirroring is disabled by default.

**NOTE**

Frames that contain errors are not mirrored.

Guidelines for Mirroring

The guidelines for mirroring are hardware dependent. Find your hardware type in this section for your specific guidelines.

Summit Family Switches

The traffic filter on Summit family switches can be defined based on one of the following criteria:

- Physical port—All data that traverses the port, regardless of VLAN configuration, is copied to the monitor port(s). You can specify which traffic the port mirrors:
 - Ingress—Mirrors traffic received at the port.
 - Egress—Mirrors traffic sent from the port.
 - Ingress and egress—Mirrors traffic either received at the port or sent from the port.
(If you omit the optional parameters, all traffic is forwarded; the default for port-based mirroring is ingress and egress).
- VLAN—All data to a particular VLAN, regardless of the physical port configuration, is copied to the monitor port(s).
- Virtual port—All data specific to a VLAN on a specific port is copied to the monitor port(s).
- Summit family switches support a maximum of 128 mirroring filters with the restriction that a maximum of 16 VLAN and/or virtual port (port + VLAN) filters may be configured.
- ExtremeXOS supports up to 16 monitor ports for one-to-many mirroring.
- Only traffic *ingressing* a VLAN can be monitored; you cannot specify ingressing or egressing traffic when mirroring VLAN traffic and a virtual port filter.

- Ingress traffic is mirrored as it is received (on the wire).
- Egress mirrored traffic always egresses the monitor port tagged.
- In normal mirroring, a monitor port cannot be added to a load share group. In one-to-many mirroring, a monitor port can be added to a load share group, but a loopback port cannot be used in a load share group.
- You can run mirroring and sFlow on the same device when you are running Summit family switches
- With a monitor port or ports on Summit family switches, all traffic ingressing the monitor port or ports is tagged only if the ingress packet is tagged. If the packet arrived at the ingress port as untagged, the packet egresses the monitor port or ports as untagged.
- Two packets are mirrored when a packet encounters both an ingress and egress mirroring filter.
- The configuration of `remote-tag` does not require the creation of a VLAN with the same tag; on these platforms the existence of a VLAN with the same tag as a configured `remote-tag` is prevented. This combination is allowed so that an intermediate remote mirroring switch can configure remote mirroring using the same remote mirroring tag as other source switches in the network. Make sure that VLANs meant to carry normal user traffic are not configured with a tag used for remote mirroring.

When a VLAN is created with `remote-tag`, that tag is locked and a normal VLAN cannot have that tag. The tag is unique across the switch. Similarly if you try to create a `remote-tag` VLAN where `remote-tag` already exists in a normal VLAN as a VLAN tag, you cannot use that tag and the VLAN creation fails.

BlackDiamond X8, BlackDiamond 8800 Series Switches and SummitStack

The traffic filter on BlackDiamond X8, BlackDiamond 8800 series switches and SummitStack can be defined based on one of the following criteria:

- Physical port—All data that traverses the port, regardless of VLAN configuration, is copied to the monitor port(s). You can specify which traffic the port mirrors:
 - Ingress—Mirrors traffic received at the port.
 - Egress—Mirrors traffic sent from the port.
 - Ingress and egress—Mirrors traffic either received at the port or sent from the port.
 (If you omit the optional parameters, all traffic is forwarded; the default for port-based mirroring is ingress and egress).
- VLAN—All data to a particular VLAN, regardless of the physical port configuration, is copied to the monitor port(s).
- Virtual port—All data specific to a VLAN on a specific port is copied to the monitor port(s).
- BlackDiamond X8, BlackDiamond 8800 series switches, and SummitStack support a maximum of 128 mirroring filters with the restriction that a maximum of 16 VLAN and/or virtual port (port + VLAN) filters may be configured.
- ExtremeXOS supports up to 16 monitor ports for one-to-many mirroring.
- Only traffic *ingressing* a VLAN can be monitored; you cannot specify ingressing or egressing traffic when mirroring VLAN traffic.
- Ingress traffic is mirrored as it is received (on the wire).
- Egress mirrored traffic always egresses the monitor port tagged.
- Two packets are mirrored when a packet encounters both an ingress and egress mirroring filter.
- With a monitor port or ports on a BlackDiamond X8 series switch, BlackDiamond 8000 series module, a Summit family switch, or a Summit family switch in a SummitStack, all ingress mirrored

traffic egressing the monitor port or ports is tagged *only* if the ingress packet is tagged. If the packet arrived at the ingress port as untagged, the packet egresses the monitor port or ports as untagged.

- With the BlackDiamond X8 series switches, BlackDiamond 8000 a-, c-, e-, xl-, and xm-series modules or Summit X250e, X440, X450a, X450e, X460, X480, X650, or X670 series switches in a SummitStack, you may see a packet mirrored twice. This occurs only if both the ingress mirrored port and the monitor port or ports are on the same one-half of the module *and* the egress mirrored port is either on the other one-half of that module or on another module.
- On BlackDiamond X8 series switches, BlackDiamond 8800 series switches, Summit family switches, or SummitStack, when traffic is modified by hardware on egress, egress mirrored packets may not be transmitted out of the monitor port as they egressed the port containing the egress mirroring filter. For example, an egress mirrored packet that undergoes VLAN translation is mirrored with the untranslated VLAN ID. In addition, IP multicast packets which are egress mirrored contain the source MAC address and VLAN ID of the unmodified packet.
- The configuration of `remote-tag` does not require the creation of a VLAN with the same tag; on these platforms the existence of a VLAN with the same tag as a configured `remote-tag` is prevented. This combination is allowed so that an intermediate remote mirroring switch can configure remote mirroring using the same remote mirroring tag as other source switches in the network. Make sure that VLANs meant to carry normal user traffic are not configured with a tag used for remote mirroring.
- When a VLAN is created with `remote-tag`, that tag is locked and a normal VLAN cannot have that tag. The tag is unique across the switch. Similarly if you try to create a `remote-tag` VLAN where `remote-tag` already exists in a normal VLAN as a VLAN tag, you cannot use that tag and the VLAN creation fails.

Mirroring Rules and Restrictions

This section summarizes the rules and restrictions for configuring mirroring:

- When you disable mirroring, all the filters are unconfigured.
- To change monitor ports, you must first remove all the filters.
- You cannot mirror the monitor port.
- The mirroring configuration is removed when you:
 - Delete a VLAN (for all VLAN-based filters).
 - Delete a port from a VLAN (for all VLAN-, port-based filters).
 - Unconfigure a slot (for all port-based filters on that slot).
- Any mirrored port can also be enabled for load sharing (or link aggregation); however, each individual port of the load-sharing group must be explicitly configured for mirroring.
- The monitor port is automatically removed from all VLANs; you cannot add it to a VLAN.
- You cannot use the management port at all in mirroring configurations.
- The mirroring filters are not confined to a single module; they can have ports that span multiple modules.
- You cannot run ELSM and mirroring on the same port. If you attempt to enable mirroring on a port that is already enabled for ELSM, the switch returns a message similar to the following:


```
Error: Port mirroring cannot be enabled on an ELSM enabled port.
```
- With one-to-many mirroring, you need to enable jumbo frame support in the mirror-to port and loopback port, if you need to mirror tagged packets of length 1519 to 1522.
- The loopback port is dedicated for mirroring and hence cannot be used for other configuration and that is indicated through glowing LED.

- Egress mirrored packets are always tagged when egressing the monitor port. If an egress mirrored packet is untagged on the egress mirrored port, the mirrored copy contains a tag with an internal VLAN ID.
- As traffic approaches line rate, mirroring rate may decrease. Since mirroring makes copies of traffic, the bandwidth available will be devoted mostly to regular traffic instead of mirrored traffic when the load is high.
- On BlackDiamond X8 Series Switches, CPU generated packets for link-based protocols (for example, EDP and LACP) are not egress mirrored. CPU generated PDUs on L2 protocol blocked ports are also not egress mirrored.

Mirroring Examples

Mirroring is disabled by default. To enable mirroring on a single port, the following command can be used:

```
enable mirroring to port <port-no>
```

To enable mirroring on multiple ports, use the following command:

```
enable mirroring to port-list <port-list> loopback-port <port>
```

The port-list is a list of monitor ports which will transmit identical copies of mirrored packets. The loopback-port is an otherwise unused port required when mirroring to a port-list. The loopback-port is not available for switching user data traffic.

To disable mirroring, use the following command:

```
disable mirroring
```



NOTE

When you change the mirroring configuration, the switch stops sending egress packets from the monitor port until the change is complete. The ingress mirroring traffic to the monitor port and regular traffic are not affected.

BlackDiamond X8 Series Switches, BlackDiamond 8800 Series Switches, SummitStack, and Summit Family Switches

The following example selects slot 3, port 4 on a modular switch or SummitStack as the monitor port and sends all traffic received at slot 6, port 5 to the monitor port:

```
enable mirroring to port 3:4
configure mirroring add port 6:5 ingress
```

The following example selects slot 3, port 4 on a modular switch or SummitStack as the monitor port and sends all traffic sent from slot 6, port 5 to the monitor port:

```
enable mirroring to port 3:4
configure mirroring add port 6:5 egress
```

The following example selects port 4 on a standalone switch as the monitor port and sends all traffic ingressing the VLAN red to the monitor port:

```
enable mirroring to port 4
configure mirroring add vlan red
```

The following example selects port 4 on a standalone switch as the monitor port and sends all traffic ingressing the VLAN red on port 5 to the monitor port:

```
enable mirroring to port 4
configure mirroring add vlan red port 5
```

The following example selects ports 5, 6, and 7 on slot 2 on a modular switch or SummitStack as the monitor ports and sends all traffic received at slot 6, port 5 to the monitor ports. Slot 3, port 1 is an unused port selected as the loopback port.

```
enable mirroring to port-list 2:5-2:7 loopback-port 3:1
configure mirroring add port 6:5 ingress
```

Verifying the Mirroring Configuration

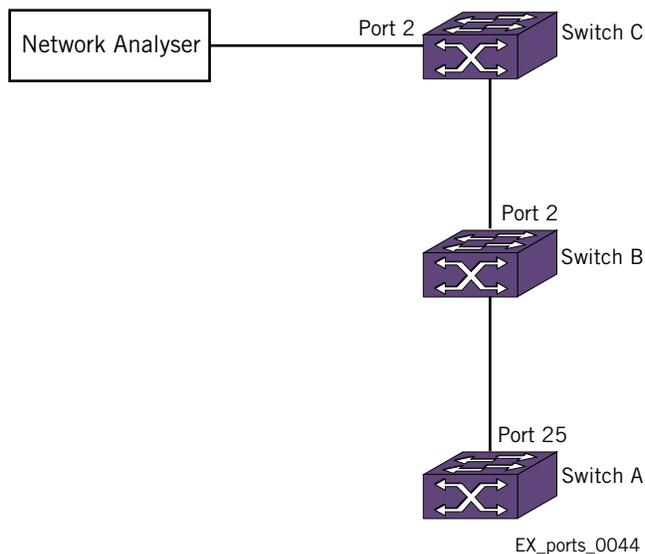
The screen output resulting from the `show mirroring` command lists the ports that are involved in mirroring and identifies the monitor port. The display differs slightly depending on the platform.

Remote Mirroring

Remote mirroring enables the user to mirror traffic to remotely connected switches. Remote mirroring allows a network administrator to mirror traffic from several different remote switches to a port at a centralized location. Remote mirroring is accomplished by reserving a dedicated VLAN throughout the network for carrying the mirrored traffic. You can enable remote mirroring on the following platforms:

- BlackDiamond X8 series switches
- BlackDiamond 8000 a-, c-, e-, xl-, and xm-series modules
- Summit Family switches

Figure 37 shows a typical remote mirroring topology. Switch A is the source switch that contains ports, VLANs, and/or virtual ports to be remotely mirrored. Port 25 is the local monitor port on Switch A. Switch B is the intermediate switch. Switch C is the destination switch, which is connected to the network analyzer.

Figure 37: Remote Mirroring Topology

All the mirrored packets are tagged with the `remote-tag` specified by the source switch, whether the packet is already tagged or not. The intermediate switches forward the remote-tagged mirrored packets to the adjacent intermediate/destination switch, as these ports are added as tagged. The port connected to the network analyser is added as untagged in the destination switch. This causes the destination switch to remove the remote-tag, and the mirrored packet reaches the network analyser as the source switch sent it.

Unlike basic mirroring, remote mirroring does not remove VLAN membership from the local monitor port(s). This allows remote mirroring to use the existing network topology to transport remote mirrored packets to a destination switch.

Configuration Details

This section describes in detail the configuration details for the topology shown in [Figure 37](#).

Configuration on Source Switch

The `remote-tag` keyword followed by the tag is added in the command to enable mirroring. For example, in the Summit X450a series switch, you can use the following command to establish ports 24 and 25 as monitor ports, from which any mirrored packets are transmitted with an additional VLAN tag containing a VLAN ID of 1000:

```
enable mirroring to port-list 24,25 loopback-port 1 remote-tag 1000
```

The `show mirroring` output displays the remote tag when remote mirroring is configured.

In the supported platforms of Summit family switches and BlackDiamond X8 and 8800 series switches, remote mirroring can also be enabled to a single port, without the `port-list` and `loopback-port` keywords. For instance, to enable remote mirroring to port 25, you can use the following command:

```
enable mirroring to port 25 remote-tag 1000
```

Configuration on Intermediate Switch

When you enable mirroring with `remote-tag 1000`, you need to reserve a VLAN with tag 1000 in all the intermediate switches for remote mirroring. The remote mirroring VLAN in the intermediate switches is used for carrying the mirroring traffic to the destination switch. The ports connecting the source and destination switches are added as tagged in the intermediate switches.

You may add the `remote-mirroring` keyword when you configure the tag to differentiate a normal VLAN from the remote mirroring VLAN.

```
create vlan remote_vlan
configure vlan remote_vlan tag 1000 remote-mirroring
configure vlan remote_vlan add ports 1,2 tagged
```

Using the `remote-mirroring` keyword automatically disables learning and IGMP snooping on the VLAN.

Another way to configure a remote mirroring VLAN is to create a normal VLAN and disable learning on the VLAN. IGMP snooping must be disabled on that VLAN for you to remotely mirror multicast packets through the switch.

You may use the following configuration for creating the remote mirroring VLAN:

```
create vlan remote_vlan
configure vlan remote_vlan tag 1000
disable learning vlan remote_vlan
disable igmp snooping remote_vlan
```

Configuration on Destination Switch

The configuration on the destination switch is same as that of the intermediate switches, except that the port connected to the network analyzer is added as untagged whereas all the other ports connected to the switches are added as tagged.

```
create vlan remote_vlan
configure vlan remote_vlan tag 1000 remote-mirroring
configure vlan remote_vlan add ports 1 tagged
configure vlan remote_vlan add ports 2 untagged
```

For a remote mirroring VLAN, the configured tag displayed by the `show vlan output` is `remote tag` instead of the normal tag.

Guidelines

The following are guidelines for remote mirroring:

- Configurations of remote mirroring, which might cause protocol packets to be remotely mirrored, are not recommended. Since all packet types are mirrored when you configure remote mirroring, remotely mirrored protocol packets may have undesirable affects on intermediate and destination switches. Blocking EDP packets on a remote mirroring VLAN is one example of a case where you must perform an extra action to accommodate the remote mirroring of protocol packets.

For EDP configuration on the remote mirroring VLAN, in the intermediate and destination switches you need to install ACL to block the EDP packets on the remote mirroring VLAN. Use the following commands for installation:

```
Create access-list remote_edp " ethernet-destination-address 00:e0:2b:00:00:00 mask
ff:ff:ff:ff:ff:ff ;" "deny"
conf access-list add "remote_edp" first vlan "remote_vlan"
```

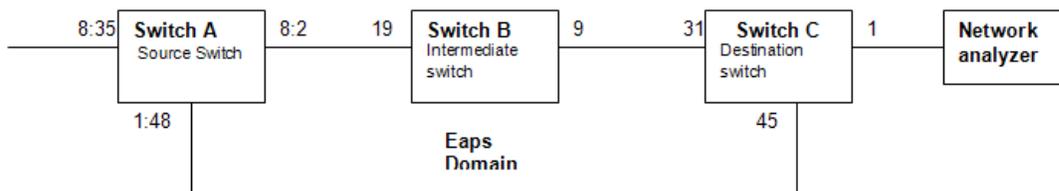
Use of Remote Mirroring with Redundancy Protocols

You can use remote mirroring with one-to-many mirroring to provide a redundant path from the source switch to the destination switch. Using EAPS or Spanning Tree can provide remote mirroring packets a redundant loop-free path through the network. You should perform the configuration of EAPS or Spanning Tree before adding mirroring filters on the source switch to prevent looping.

Remote Mirroring with EAPS

In [Figure 38](#), the traffic from switch A is mirrored to the two ports 8:2 and 1:48 to connect to the destination switch. Using the configuration shown in [Figure 38](#), remote mirrored packets have a loop-free redundant path through the network using EAPS.

Figure 38: Remote Mirroring with EAPS



The configuration for the topology in [Figure 38](#) is given in the following sections.

Switch A Configuration

The configuration details for a BlackDiamond 8810 switch are as follows:

```
configure mirroring mode enhanced
enable mirroring to port-list 8:2,1:48 loopback-port 8:1 remote-tag 1000
configure mirroring add port 8:35
```

```
create vlan eaps_control
configure vlan eaps_control tag 1001
configure vlan eaps_control add ports 8:2,1:48 tag
```

```
create eaps eaps1
configure eaps1 mode master
configure eaps1 primary port 8:2
configure eaps1 secondary port 1:48
configure eaps1 add control eaps_control
configure eaps1 add protected internalMirrorLoopback
enable eaps1
enable eaps
```

Switch B Configuration

The configuration details for a Summit X450e switch are as follows:

```
create vlan remote_vlan
configure vlan remote_vlan tag 1000 remote-mirroring
configure vlan remote_vlan add ports 19,9 tag

create vlan eaps_control
configure vlan eaps_control tag 1001
configure vlan eaps_control add ports 19,9 tag

create eaps eaps1
configure eaps1 mode transit
configure eaps1 primary port 19
configure eaps1 secondary port 9
configure eaps1 add control eaps_control
configure eaps1 add protected remote_vlan
enable eaps1
enable eaps
```

Switch C configuration

The configuration details for a Summit X450a switch are as follows:

```
create vlan remote_vlan
configure vlan remote_vlan tag 1000 remote-mirroring
configure vlan remote_vlan add ports 31,45 tag
configure vlan remote_vlan add ports 1

create vlan eaps_control
configure vlan eaps_control tag 1001
configure vlan eaps_control add ports 31,45 tag

create eaps eaps1
configure eaps1 mode transit
configure eaps1 primary port 31
configure eaps1 secondary port 45
configure eaps1 add control eaps_control
configure eaps1 add protected remote_vlan
enable eaps1
enable eaps
```



NOTE

The `internalMirrorLoopback` is an internal VMAN created when enabling mirroring to multiple ports. Depending on the platform, the internal VLAN or VMAN needs to be added as the protected VLAN in the source switch in order to block the ports for mirroring when EAPS is complete.

Remote Mirroring With STP

For the same topology shown in [Figure 38](#) you can use STP instead of using EAPS. A sample configuration follows.

Switch A Configuration

```
configure mirroring mode enhanced
enable mirroring to port-list 8:2,1:48 loopback-port 8:1 remote-tag 1000
configure mirroring add port 8:35

create vlan v1
configure vlan v1 tag 1001
configure vlan v1 add ports 8:2,1:48 tag

create stp stp1
configure stp1 mode dot1w
configure stp1 add v1 ports all
configure stp1 tag 1001
configure stp1 add vlan internalMirrorLoopback ports 8:2,1:48
enable stp1
enable stpd
```

Switch B Configuration

```
create vlan remote_vlan
configure vlan remote_vlan tag 1000 remote-mirroring
configure vlan remote_vlan add ports 19,9 tag

create vlan v1
configure vlan v1 tag 1001
configure vlan v1 add ports 19,9 tag

create stp stp1
configure stp1 mode dot1w
configure stp1 add v1 ports all
configure stp1 tag 1001
configure stp1 add vlan remote_vlan ports all
enable stp1
enable stpd
```

Switch C Configuration

```
create vlan remote_vlan
configure vlan remote_vlan tag 1000 remote-mirroring
configure vlan remote_vlan add ports 31,45 tag
configure vlan remote_vlan add ports 1

create vlan v1
configure vlan v1 tag 1001
configure vlan v1 add ports 31,45 tag

create stp stp1
configure stp1 mode dot1w
```

```
configure stp1 add v1 ports all
configure stp1 tag 1001
configure stp1 add vlan remote_vlan ports 31,45
enable stp1
enable stpd
```

Extreme Discovery Protocol

The Extreme Discovery Protocol (EDP) is used to gather information about neighbor Extreme Networks switches. EDP is used by the switches to exchange topology information. Information communicated using EDP includes:

- Switch MAC address (switch ID)
- Switch software version information
- Switch IP address
- Switch VLAN IP information
- Switch port number
- Switch configuration data: duplex and speed

EDP is enabled on all ports by default. EDP enabled ports advertise information about the Extreme Networks switch to other switches on the interface and receives advertisements from other Extreme Networks switches. Information about other Extreme Networks switches is discarded after a timeout interval is reached without receiving another advertisement.

To disable EDP on one or more ports, use the following command:

```
disable edp ports [<ports> | all]
```

To enable EDP on specified ports, use the following command:

```
enable edp ports [<ports> | all]
```

To clear EDP counters on the switch, use the following command:

```
clear counters edp
```

This command clears the following counters for EDP protocol data units (PDUs) sent and received per EDP port:

- Switch PDUs transmitted
- VLAN PDUs transmitted
- Transmit PDUs with errors
- Switch PDUs received
- VLAN PDUs received
- Received PDUs with errors

To view EDP port information on the switch, use the following command:

```
show edp
```

Additionally, you view EDP information by using the following command:

```
show edp port <ports> detail
```

To configure the advertisement interval and the timeout interval, use the following command:

```
configure edp advertisement-interval <timer> holddown-interval <timeout>
```

Refer to “[Displaying Port Information](#)” for information on displaying EDP status.

Software-Controlled Redundant Port and Smart Redundancy

Using the software-controlled redundant port feature you can back up a specified Ethernet port (primary) with a redundant, dedicated Ethernet port; both ports are on the same switch. If the primary port fails, the switch will establish a link on the redundant port and the redundant port becomes active. Only one side of the link must be configured as redundant because the redundant port link is held in standby state on both sides of the link. This feature provides very fast path or network redundancy.



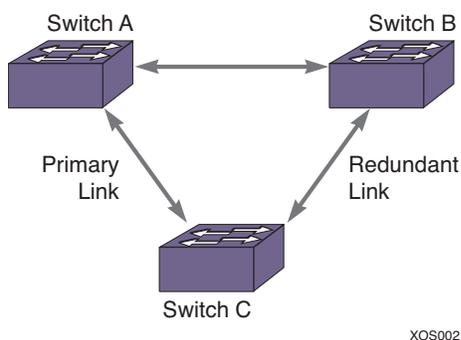
NOTE

You cannot have any Layer 2 protocols configured on any of the VLANs that are present on the ports.

Smart Redundancy is a feature that allows control over how the failover from a redundant port to the primary port is managed. If this feature is enabled, which is the default setting, the switch attempts to revert to the primary port as soon as it can be recovered. If the feature is disabled, the switch attempts only to recover the primary port to active if the redundant port fails.

A typical configuration of software-controlled redundant ports is a dual-homed implementation ([Figure 39](#)). This example maintains connectivity only if the link between switch A and switch B remains open; that link is outside the scope of the software-controlled port redundancy on switch C.

Figure 39: Dual-Homed Implementation for Switch C



In normal operation, the primary port is active and the software redundant switch (switch C in [Figure 39](#)) blocks the redundant port for all traffic, thereby avoiding a loop in the network. If the switch detects that the primary port is down, the switch unblocks the redundant port and allows traffic to flow through that redundant port.



NOTE

The primary and redundant ports must have identical VLAN membership.

You configure the software-controlled redundant port feature either to have the redundant link always physically up but logically blocked or to have the link always physically down. The default value is to have the link physically down, or Off.

By default, Smart Redundancy is always enabled. If you enable Smart Redundancy, the switch automatically fails over to the redundant port and returns traffic to the primary port after connectivity is restored on that port. If you do not want the automatic restoration of the primary link when it becomes active, disable Smart Redundancy.

Guidelines for Software-Controlled Redundant Ports and Port Groups

Software-controlled redundant ports and port groups have the following limitations:

- You cannot have any Layer 2 protocols configured on any of the VLANs that are present on the ports. (You will see an error message if you attempt to configure software redundant ports on ports with VLANs running Layer 2 protocols.)
- The primary and redundant ports must have identical VLAN membership.
- The master port is the only port of a load-sharing group that can be configured as either a primary or redundant port. Also, all ports on the load-sharing group must fail before the software-controlled redundancy is triggered.
- You must disable the software redundancy on the master port before enabling or disabling load sharing.
- You can configure only one redundant port for each primary port.
- Recovery may be limited by FDB aging on the neighboring switch for unidirectional traffic. For bi-directional traffic, the recovery is immediate.

Configuring Software-Controlled Redundant Ports

When provisioning software-controlled redundant ports, configure only one side of the link as redundant. In [Figure 39](#) only the ports on switch C would be configured as redundant.



NOTE

To enable the software-controlled redundant port feature, the primary and redundant ports must have identical VLAN membership.

To configure a software-controlled redundant port, use the following command:

```
configure ports <primaryPort> redundant <secondaryPort> {link [on | off]}
```

The first port specified is the primary port. The second port specified is the redundant port.

To unconfigure a software-controlled redundant port, use the following command and enter the primary port(s):

```
unconfigure ports <port_list> redundant
```

To configure the switch for the Smart Redundancy feature, use the following command:

```
enable smartredundancy <port_list>
```

To disable the Smart Redundancy feature, use the following command:

```
disable smartredundancy <port_list>
```

Verifying Software-Controlled Redundant Port Configurations

You can verify the software-controlled redundant port configuration by issuing a variety of CLI commands.

To display the redundant ports as well as which are active or members of load-sharing groups, use the following command:

```
show ports redundant
```

To display information on which ports are primary and redundant software-controlled redundancy ports, use the following command:

```
show ports {mgmt | <port_list> | tag <tag>} information {detail}
```

Refer to “[Displaying Port Information](#)” for more information on the `show ports information` command.

Configuring Automatic Failover for Combination Ports

Summit Family Switches with Shared Copper/Fiber Gigabit Ports Only.

On Summit family switches with shared copper/fiber gigabit ports, you configure *automatic failover* using the combination ports. These ports are called *combination* ports because either the fiber port or the copper port is active, but they are never active concurrently. These ports, also called redundant ports, are shared PHY copper and fiber ports.

If you plan to use the automatic failover feature, ensure that port settings are set correctly for autonegotiation.



NOTE

You may experience a brief episode of the link going down and recovering during the failover.

To display the port type currently used as well as the preferred media setting, use the following command:

```
show ports {mgmt | <port_list> | tag <tag>} information {detail}
```

Refer to “[Displaying Port Information](#)” for more information on the `show ports information` command.

There are four ports on the Summit X450a and X450e series switches that are designed as combination ports for uplink redundancy. When sharing ports, only the fiber medium or only the copper medium can be active at one time. If the copper medium goes down while transmitting packets, the fiber medium activates and becomes the primary link; and vice-versa.

Hardware determines when a link is lost and swaps the primary and redundant ports to maintain stability. After a failover occurs, the switch keeps or sticks with the current port assignment until there is another failure or until a user changes the assignment using the CLI. To change the uplink failover assignment, use the following command:

```
configure ports <port_list> preferred-medium [copper | fiber] {force}
```

The default preferred-medium is fiber. If you use the `force` option, it disables automatic failover. If you force the preferred-medium to fiber and the fiber link goes away, the copper link is not used, even if available.

**NOTE**

For more information about combination ports on Summit family switches, refer to the Summit Family Switches Hardware Installation Guide.

Displaying Port Information

You display summary port configuration information using the `show ports {mgmt | <port_list> | tag <tag>} configuration {no-refresh}` and `show ports {mgmt | <port_list> | tag <tag>} information {detail}` commands.

The `show ports configuration` command shows you either summary configuration information on all the ports, or more detailed configuration information on specific ports. If you specify the `no-refresh` parameter, the system displays a snapshot of the data at the time you issue the command.

The `show ports information` command shows you either summary information on all the ports, or more detailed information on specific ports. The output from the command differs very slightly depending on the platform you are using.

You can display real-time port utilization information, by issuing the following command:

```
show ports {mgmt | <port_list> | tag <tag> | stack-ports <stacking-port-list>}
utilization {bandwidth | bytes | packets}
```

When you use a parameter (packets, byte, or bandwidth) with the above command, the display for the specified type shows a snapshot per port when you issued the command.

DDMI

Digital Diagnostic Monitoring Interface (DDMI) provides critical information about the installed optical module. It can be used to monitor the condition on XFP, SFP, and SFP+ optical transceiver modules.

The following information is displayed:

- Temperature of the modules in Celsius
- Transmit power in dBm for the module
- Receive power in dBm for the module
- Bias current in mA for the module
- Voltage - AUX-1
- Voltage - AUX-2 (Typically, SFP/SFP+ optics do not support monitoring AUX-2 voltage.)

The feature is supported on the following platforms:

- BlackDiamond 8800—10G8Xc, 10G4Xc, 10G4Xa modules and S-10G1Xc option cards with 10G XFP optics
- BlackDiamond 8900—10G8X-xl modules and S-10G1Xc option cards with 10G XFP optics

- Summit X250e switches—SFP ZX and LX100 optics
- Summit X450a, X450e switches—SFP ZX and LX100 optics
- Summit X460 switch—SFP ZX and LX100 optics and SFP+ SR, LR and ER optics
- Summit X480 switches and X480 VIM2-10G4X—XFP and SFP ZX and LX100 optics
- Summit X650 switches—SFP ZX and LX100 optics and SFP+ optics ER/LR
- Summit X670 switches—SFP ZX and LX100 1G optics and SFP+ 10G optics

To display basic or detailed system information about these optical modules, use the following commands:

```
show ports {<port-list> | tag <tag>} transceiver information  
or  
show ports {<port-list> | tag <tag>} transceiver information detail
```


6

CHAPTER

Universal Port

This chapter includes the following sections:

- [Overview on page 327](#)
- [Configuring Universal Port Profiles and Triggers on page 343](#)
- [Managing Profiles and Triggers on page 347](#)
- [Sample Universal Port Configurations on page 350](#)

Overview

Universal Port is a flexible framework that enables automatic switch configuration in response to special events such as:

- User login and logoff
- Device connection to or disconnection from a port
- Time of day
- Event Management System event messages



NOTE

The Universal Port feature is supported only on the platforms listed for this feature in the license tables in [Appendix A, “Feature License Requirements.”](#)

The primary component of the Universal Port feature is the *profile*, which is a special form of command script that runs when triggered by the events mentioned above. Profiles execute commands and use variables as do the scripts described in [Chapter 7, “Using CLI Scripting.”](#) The primary difference is that a profile can be executed manually or automatically, in response to switch events.



NOTE

Special scripts can be run when the switch boots. For more information, see [“Using Autoconfigure and Autoexecute Files” on page 1497.](#)

Universal Port works with the following ExtremeXOS components and third-party products:

- ExtremeXOS Network Login (see [Chapter 21, “Network Login”](#))
- ExtremeXOS LLDP (see [Chapter 8, “LLDP”](#))
- ExtremeXOS CLI Scripting (see [Chapter 7, “Using CLI Scripting”](#))
- ExtremeXOS Event Management System (see [Chapter 11, “Status Monitoring and Statistics”](#))
- RADIUS servers (see [Chapter 23, “Security”](#))
- Active directory services such as LDAP and Microsoft Active Directory

The following are some examples of how you can use Universal Port on a network:

- Automatically provision a VoIP phone and the attached switch port with appropriate Power over Ethernet (PoE) budget and Quality of Service (QoS) settings when the phone connects.
- Create security policies that can follow a user as the user roams around a campus. For example, an engineer can walk from Building 1 to Building 5, plug his PC into the network and be authenticated with the appropriate access rights and ACLs.
- Support separate authentication for VoIP phones and workstations on the same port.
- Create profile templates with variables so that you can re-use templates with different address ranges and parameters.
- Apply different security policies for different locations (for example, a restricted area).
- Disable wireless access after business hours.



NOTE

The term *profile* is distinct from the term *policy* because a policy is only one particular application of a profile.

The following sections introduce Universal Port concepts:

- [Profile Types on page 328](#)
- [Dynamic Profile Trigger Types on page 330](#)
- [How User Authentication Profiles Work on page 334](#)
- [How Device Detect Profiles Work on page 333](#)
- [Profile Configuration Guidelines on page 334](#)
- [Collecting Information from Supplicants on page 339](#)
- [Supplicant Configuration Parameters on page 341](#)
- [Universal Port Configuration Overview on page 341](#)
- [Using Universal Port in an LDAP or Active Directory Environment on page 343](#)

Profile Types

The ExtremeXOS software supports two types of profiles: *static* and *dynamic*. The following sections describe these profile types:

- [Static Profiles on page 329](#)
- [Dynamic Profiles on page 329](#)

Static Profiles

Static profiles are so named because they are not triggered by dynamic system events. To trigger a static profile, you must enter a CLI command at the switch prompt or run a script that contains the command to start a static profile. The following guidelines apply to static profiles:

- Static profiles are not limited to individual ports and can include system wide configuration changes.
- Static profiles are not assigned to a port and are not specific to a device or a user.
- Changes made by static profiles are persistent. They are saved in the switch configuration and are preserved during system reboots.

Static profiles are typically used to establish default switch settings. Using scripts and variables, you can create static profiles that serve as templates for initializing switches or reconfiguring switches to manually respond to network or business events. These templates can simplify complex configuration tasks such as Netlogin.

Dynamic Profiles

Dynamic profiles are so named because they are dynamically triggered by the following types of events:

- Device discovery and disconnect
- User or standards-based authentication and logoff
- Time of day
- Switch events reported by the Event Management System (EMS)

Dynamic profiles are event or action driven and do not require an administrator to start the profile.

Without dynamic profile support, IT personnel must be available when devices are added, moved, or changed so they can configure both the network port and the new device. These tasks typically take a long time, do not support mobility, and are often prone to human error.

When dynamic profiles are configured properly and a device connects to an edge port, a triggering event triggers a profile that runs a script to configure the port appropriately. The script can use system run-time variables and information gathered from tools such as NetLogin and LLDP to customize the port configuration for the current network environment. For example, the profile can customize the port configuration based on the user ID or MAC address. Dynamic profiles allow you to automate the network response to a variety of network events.

Dynamic profiles create temporary states. For example, if a power outage causes the switch to restart, all ports return to the default configuration. When a triggering event such as a specific device connection occurs again, the profile is applied again. When the device is no longer connected, the disconnect event can trigger another profile to unconfigure the port.

The temporary state configured by a dynamic profile is configured by prepending the `configure cli mode non-persistent` command to the script. The temporary nature of profile configuration is critical for network security. Imagine a situation where a dynamic security profile is used. If the information granting access to specific network resources is saved in the configuration, the switch is restarted, and a user loses network connectivity on a secure port, the secure port still provides network access after the switch restarts. Anybody else can access network resources simply by connecting to that secure port.

Although the switch configuration returns to the default values after a restart, there is no automatic configuration rollback for dynamic profiles. For example, if a profile grants secure access to network resources at user login, the configuration is not automatically rolled back when the user logs off. To roll

back the configuration at user log off, you must create another profile that responds to user log-off events.

To support configuration rollback, the scripting feature allows you to save information used in dynamic profiles in variables. When a profile is activated and you want the option to roll back to the previous default setting, some information must be saved, such as the default VLAN setting or the default configuration of a port. Essentially anything modified from the previous setting can be preserved for future use by the profile that rolls back the configuration.

There can be multiple profiles on a switch, but only one profile runs at a time. Data from a trigger event is used to select the appropriate profile, and that data can also be used to make decision points within a profile. A typical example is the use of a RADIUS server to specify a particular profile and then apply port-based policies to the user based on the user's location.

There is no profile hierarchy and no software validation to detect if a new profile conflicts with older profile. If two profiles conflict, the same profile might produce different results, depending on the events leading up to the profile trigger. When you create profiles, you must be familiar with all profiles on the switch and avoid creating profiles that conflict with each other.

Dynamic Profile Trigger Types

The following sections introduce each of the dynamic profile trigger types:

- [Device Triggers on page 330](#)
- [User Authentication Triggers on page 331](#)
- [Time Triggers on page 332](#)
- [Event Management System Triggers on page 333](#)

Device Triggers

Device triggers launch a profile when a device connects to or disconnects from a port. The two types of device triggers are labeled *device-detect* and *device-undetected* in the software. Profiles that respond to these triggers are called *device-detect profiles* or *device-undetected profiles*.

Typically, a device-detect profile is used to configure a port for the device that has just connected. Likewise, a device-undetected profile is used to return the port to a default configuration after a device disconnects. A variety of different devices can be connected to a port. When devices connect to the network, Universal Port helps provide the right configuration at the port.

Device triggers respond to the discovery protocols IEEE 802.1ab LLDP and ANSI/TIA-1057 LLDP-MED for Voice-over-IP (VoIP) phone extensions. A device-detect trigger occurs when an LLDP packet reaches a port that is assigned to a device-detect profile. A device-undetected trigger occurs when periodically transmitted LLDP packets are not received anymore. LLDP age-out occurs when a device has disconnected or an age-out time has been reached. LLDP must be enabled on ports that are configured for device-detect or device-undetected profiles. LLDP is described in [Chapter 8, "LLDP."](#)

The combination of device triggers and LLDP enables the custom configuration of devices that connect to switch ports. For example, Voice-over-IP (VoIP) phones can send and receive information in addition to normal device identification information. The information sent through LLDP can be used to identify the maximum power draw of the device. The switch can then set the maximum allocated power for that port.

If the switch does not have enough PoE left, the switch can take action to lower the PoE loading and try again. The switch can also transmit additional VoIP files and call server configuration information to the phone so the phone can register itself and receive necessary software and configuration information.

There can only be one device-detect profile and one device-undetected profile per port. To distinguish between different connecting devices, you can use if-then-else statements in a profile along with detailed information provided through LLDP.

User Authentication Triggers

User authentication triggers launch a profile when a user or an identified device logs in or out of the network using the network login feature described in [Chapter 21, “Network Login.”](#) The network login feature does not permit any access beyond the port until the user or device is authenticated.

The two types of user authentication triggers are labeled *user-authenticate* and *user-unauthenticated* in the software. Profiles that respond to these triggers are called *user-authenticate profiles* or *user-unauthenticated profiles*. Typically, a user-authenticate profile is used to configure a port for a user and device that has just connected. Likewise, a user-unauthenticated profile is used to return the port to a default configuration after a user or device disconnects. Successful network login triggers the user-authenticate profile, and either an explicit logout, a session time out, or a disconnect triggers the user-unauthenticated profile.



NOTE

VoIP phones are also capable of being authenticated before being allowed on the network. The phone begins 802.1x authentication based on a personal username and password. This authentication step is available and supported by the latest firmware from vendors such as Avaya and Mitel.

Network login requires a RADIUS server for user or device authentication. The RADIUS server provides the following features:

- Centralized database for network authentication
- Further centralization when connected to an LDAP or Active Directory database
- Dynamic switch configuration through Vendor Specific Attributes (VSAs)

VSAs are values that are passed from the RADIUS server to the switch after successful authentication. VSAs can be used by the switch to configure connection attributes such as security policy, VLAN, and location. For more information on RADIUS and VSAs, see [Chapter 23, “Security.”](#)

The following sections introduce each of the network login event types that can trigger profiles:

- [802.1x Network Login on page 331](#)
- [MAC-Based Network Login on page 332](#)
- [Web-Based Network Login on page 332](#)

802.1x Network Login. Network login 802.1x requires 802.1x client software on the device to be authenticated. At login, the user supplies a user name and password, which the switch passes to the RADIUS server for authentication. When the user passes authentication, the RADIUS server notifies the switch, and the user-authenticate profile is triggered.

One advantage of 802.1x network login is that it can uniquely identify a user. A disadvantage is that not all devices support 802.1x authentication. For more information, see [Chapter 21, “Network Login.”](#)

MAC-Based Network Login. MAC-based network login requires no additional software, and it does not require any interaction with the user. When network login detects a device with a MAC address that is configured on the switch, the switch passes the MAC address and an optional password to the RADIUS server for authentication. When the device passes authentication, the RADIUS server notifies the switch, and the user-authenticate profile is triggered.

One advantage of MAC-based network login is that it requires no special software. A disadvantage is that security is based on the MAC address of the client, so the network is more vulnerable to spoofing attacks. For more information, see [Chapter 21, “Network Login.”](#)

**NOTE**

MAC-based authentication can also be used to identify devices. For example, an entire MAC address or some bits of the MAC address can identify a device and trigger switch port auto-configuration similar to the LLDP-based device detect event. The difference between MAC-based authentication and LLDP authentication is that MAC-based authentication does not provide information on the connected device. The advantage of MAC-based authentication is that it enables non-LLDP devices to trigger profiles.

Web-Based Network Login. Web-based network login requires a DHCP server and may require a DNS server. At login, the user supplies a user name and password through a Web browser client, which the switch passes to the RADIUS server for authentication. When the user passes authentication, the RADIUS server notifies the switch, and the user-authenticate profile is triggered.

Some advantages of Web-based network login are that it can uniquely identify a user and it uses commonly available Web client software. Some disadvantages are a lower level of security and the IP configuration requirement. For more information, see [Chapter 21, “Network Login.”](#)

Time Triggers

Time triggers launch a profile at a specific time of day or after a specified period of time. For example, you can use time triggers to launch profiles at the following times:

- 6 p.m. every day
- One-time after 15 minutes
- 1 hour intervals

You might use a time trigger to launch a profile to disable guest VLAN access, shut down a wireless service, or power down a port after business hours. Time triggers enable profiles to perform timed backups for configurations, policies, statistics, and so forth. Anything that needs to happen on a regular basis or at a specific time can be incorporated into a time-of-day profile.

A profile that uses a time trigger is called a *time-of-day profile*. Time-of-day profiles are not limited to non-persistent-capable CLI commands and can use any command in the ExtremeXOS CLI.

Unlike the device-detect and user-authenticate triggers, time triggers do not have an equivalent function to the device-undetected or user-unauthenticated triggers. If you need the ability to unconfigure changes made in a time-of-day profile, just create another time-of-day profile to make those changes.

Event Management System Triggers

EMS-event triggers launch a profile when EMS produces a message that conforms to a predefined definition that is configured on the switch. The ExtremeXOS EMS feature is described in [Chapter 11, “Status Monitoring and Statistics.”](#)

Profiles that respond to EMS-event triggers are called *EMS-event profiles*. Typically, an EMS-event profile is used to change the switch configuration in response to a switch or network event.

The EMS events that trigger Universal Port profiles are defined in EMS filters and can be specified in more detail with additional CLI commands. You can create EMS filters that specify events as follows:

- Component.subcomponent
- Component.condition
- Component.subcomponent.condition

You can use the `show log components` command to display all the components and subcomponents for which you can filter events. If you specify a filter to take action on a component or subcomponent, any event related to that component triggers the profile. You can use the `show log events all` command to display all the conditions or events for which you can filter events. If you decide that you want to configure a profile to take action on an ACL policy change, you can add a filter for the `ACL.Policy.Change` event.

You can further define an event that triggers a Universal Port profile by specifying an event severity level and text that must be present in an event message.

When a specified event occurs, event information is passed to the Universal Port profile in the form of variables, which can be used to modify the switch configuration.

EMS-triggered profiles allow you to configure responses for any EMS event listed in the `show log components` and `show log events all` commands. However, you must be careful to select the correct event and corresponding response for each profile. For example, if you attempt to create a Universal Port log target for a specific event (`component.subcomponent.condition`) and you accidentally specify a component (`component`), the profile is applied to all events related to that component. Using EMS-triggered profiles is similar to switch programming. They provide more control and therefore more opportunity for misconfiguration.

Unlike the device-detect and user-authenticate triggers, EMS event triggers do not have an equivalent function to the device-undetected or user-unauthenticated triggers. If you need the ability to unconfigure changes made in an EMS-event profile, just create another static or dynamic profile to make those changes.

How Device Detect Profiles Work

Device detect profiles enable dynamic port configuration without the use of a RADIUS server. Device-detect profiles and device undetect profiles are triggered as described earlier in [“Device Triggers” on page 330](#).

When a device connects to a port that has a device-detect profile configured, the switch runs the specified profile and stops. Only one device detect profile can be configured for a port, so the same profile runs each time a device is detected on the port. Only one device-undetected profile can be configured for a port, so the same profile is run each time the switch detects that all previously-connected devices are no longer connected.

How User Authentication Profiles Work

User-authentication profiles can be assigned to user groups or individual users. Typically, a company creates profiles for groups such as software engineering, hardware engineering, marketing, sales, technical support, operations, and executive. These kinds of categories make profile management more streamlined and simple.

The authentication process starts when a switch receives an authentication request through network login. The authentication request can be for a specific user or a MAC address. A user name and password might be entered directly or by means of other security instruments, such as a smart card. A MAC address would be provided by LLDP, which would need to be operating on the ingress port. Network login enforces authentication before granting access to the network. All packets sent by a client on the port do not go beyond the port into the network until the user is authenticated through a RADIUS server.

The switch authenticates the user through a RADIUS server, which acts as a centralized authorization point for all network devices. The RADIUS server can contain the authentication database, or it can serve as a proxy for a directory service database, such as LDAP or Active Directory. The switch also supports optional backup authentication through the local switch database when a RADIUS server is unavailable.

The RADIUS server responds to the switch and either accepts or denies user authentication. When user authentication is accepted, the RADIUS server can also send Vendor Specific Attributes (VSAs) in the response. The VSAs can specify configuration data for the user such as the Universal Port profile to run for logon, a VLAN name, a user location, and a Universal Port profile to run for logout. Extreme Networks has defined vendor specific attributes that specify configuration settings and can include variables to be processed by the Universal Port profile. If profile information is not provided by the RADIUS server, the user-authenticate profile is used.

Profiles are stored and processed on the switch. When a user name or MAC address is authenticated, the switch places the appropriate port in forwarding mode and runs either a profile specified by the RADIUS server, or the profile defined for the authentication event. The profile configures the switch resources for the user and stops running until is activated again.

When a user or MAC address is no longer active on the network, due to logoff, disconnect, or inactivity, user unauthentication begins. To complete unauthentication, the switch stops forwarding on the appropriate port and does one of the following:

- 1 Run an unauthenticate profile specified by the RADIUS server during authentication
- 2 Run an unauthenticate profile configured on the switch and assigned to the affected port
- 3 Run the authenticate profile used to authenticate the user initially

The preferred unauthenticate profile is one specified by the RADIUS server during authentication. If no unauthenticate profiles are specified, the switch runs the authenticate profile used to authenticate the user or device.

Profile Configuration Guidelines

You can configure both static and dynamic profiles using the command line interface (CLI) or the Ridgeline Universal Port Manager.

This section presents the following topics:

- [Obtaining Profiles on page 335](#)
- [Profile Rules on page 335](#)
- [Multiple Profiles on the Same Port on page 335](#)
- [Supported Configuration Commands and Functions on page 336](#)
- [Universal Port Variables on page 337](#)

Obtaining Profiles

You can write your own profiles, or you can obtain profiles from the Extreme Networks website, another Extreme Networks user or partner, or Extreme Networks professional services. Sample profiles are listed in “[Sample Universal Port Configurations](#)” on page 350. The Universal Port Handset Provisioning Module is a collection of profiles and documentation that is available with other samples on the Extreme Networks website.

Profile Rules

All profiles have the following restrictions:

- Maximum 5000 characters in a profile.
- Maximum 128 profiles on a switch.
- Profiles are stored as part of the switch configuration file.
- Copy and paste is the only method to transfer profile data using the CLI.
- Unless explicitly preceded with the command `configure cli mode persistent`, all non-persistent-capable commands operate in non-persistent mode when operating in dynamic profiles.
- Unless explicitly preceded with the command `configure cli mode non-persistent`, all non-persistent-capable commands operate in persistent mode when operating in static profiles.



NOTE

There is no profile hierarchy, which means users must verify there are no conflicting rules in static and dynamic profiles. This is a normal requirement for ACLs, and is standard when using policy files or dynamic ACLs.



NOTE

When the switch is configured to allow non-persistent-capable commands to operate in non-persistent mode, the switch configuration can roll back to the configuration that preceded the entry of the non-persistent-capable commands. This roll back behavior enables ports to return to their initial state when a reboot or power cycle occurs.

Multiple Profiles on the Same Port

Multiple Universal Port profiles can be created on a switch, but only one profile per event can be applied per port. Different profiles on the same port apply to different events; for example, different authentication events for different devices or users.

You can configure multiple user profiles on a port or a group of ports. For instance, you might create user-authentication profiles for different groups of users, such as Engineering, Marketing, and Sales. You can also configure a device-triggered profile on a port that supports one or more user profiles. However, you can configure only one device-triggered profile on a port.

Supported Configuration Commands and Functions

Static and dynamic profiles support the full ExtremeXOS command set and the built-in functions described in [Chapter 7, “Using CLI Scripting.”](#) However, a subset of these commands operates by default in non-persistent mode when executed in a dynamic profile. Commands that are executed in persistent mode become part of the saved switch configuration that persists when the switch is rebooted. Commands that are executed in non-persistent mode configure temporary changes that are not saved in the switch configuration and do not persist when the switch is rebooted.

Most commands operate only in persistent mode. The subset of commands that operate in non-persistent mode are called non-persistent-capable commands. The Universal Port feature uses the non-persistent-capable commands to configure temporary changes that could create security issues if the switch were rebooted or reset. The use of non-persistent-capable commands in scripts and Universal Port profiles allows you to make temporary configuration changes without affecting the default configuration the next time the switch is started.

[Table 32](#) shows the non-persistent capable CLI commands.

Table 32: Non-Persistent-Capable Configuration Commands

CLI Commands
<p>ACL Commands</p> <p>Dynamic ACL syntax allows the application of all ACLs</p> <pre>configure access-list add <dynamic_rule> [[[first last] {priority <p_number>} {zone <zone>}] [[before after] <rule>] [priority <p_number> {zone <zone>}]] [any vlan <vlaname> ports <portlist>] {ingress egress}</pre> <pre>configure access-list delete <ruleName> [any vlan <vlaname> ports <portlist> all] {ingress egress}</pre>
<p>LLDP</p> <pre>configure lldp ports <portlist> [advertise don't-advertise]...</pre>
<p>Port</p> <pre>disable port [<port_list> all]</pre> <pre>disable jumbo-frame ports [all <port_list>]</pre> <pre>enable port [<port_list> all]</pre> <pre>enable jumbo-frame ports [all <port_list>]</pre>
<p>Power over Ethernet</p> <pre>configure inline-power label <string> ports <port_list></pre> <pre>configure inline-power operator-limit <milliwatts> ports [all <port_list>]</pre> <pre>configure inline-power priority [critical high low] ports <port_list></pre>

Table 32: Non-Persistent-Capable Configuration Commands (Continued)

CLI Commands
<pre> disable inline-power disable inline-power ports [all <port_list>] disable inline-power slot <slot> enable inline-power enable inline-power ports [all <port_list>] enable inline-power slot <slot> unconfigure inline-power priority ports [all <port_list>] </pre>
<p>VLAN</p> <pre> configure {vlan} <vlan_name> add ports [<port_list> all] {tagged untagged} {{stpd} <stpd_name>} {dot1d emistp pvst-plus}} configure ip-mtu <mtu> vlan <vlan_name> </pre>
<p>QOS/Rate-limiting</p> <p>802.1p priority assignment to traffic on a port</p> <pre> configure ports <port_list> {qosprofile} <qosprofile> </pre>
<p>Show Commands</p> <p>All show commands can be executed in non-persistent mode.</p>

By default, all commands operate in persistent mode with the following exceptions:

- In Universal Port dynamic profiles, the non-persistent-capable commands operate in non-persistent mode unless preceded by the `configure cli mode persistent` command in the profile.
- In the CLI, CLI scripts, and static profiles, the non-persistent-capable commands operate in non-persistent mode only when preceded by the `configure cli mode non-persistent` command.

You can use the `configure cli mode persistent` command and the `configure cli mode non-persistent` command to change the mode of operation for non-persistent-capable commands multiple times within a script, profile, or configuration session.

Universal Port Variables

Universal Port uses CLI Scripting variables (see [Chapter 7, “Using CLI Scripting”](#)) to make system and trigger event information available to profiles. Variables allow you to create profiles and scripts that respond to the state of the switch as defined in the variables. When a profile is triggered, the system passes variables to the profile. You can also create and use variables of your own. User-defined variables are limited to the current context unless explicitly saved.



NOTE

You must enable CLI scripting before using variables or executing a script.

If you save variables (as described in [“Saving, Retrieving, and Deleting Session Variables”](#) on page 384), certain data from one profile can be reused in another profile for another event. For example, between login and logout events, the data necessary for the rollback of a port configuration can be shared.

The following sections describe the variables that are available to profiles:

- [Common Variables on page 338](#)
- [User Profile Variables on page 338](#)
- [Device Detect Profile Variables on page 339](#)
- [Event Profile Variables on page 339](#)

Common Variables. Table 33 shows the variables that are always available for use by any script. These variables are set up for use before a script or profile is executed.

Table 33: Common Variables

Variable Syntax	Definition
\$STATUS	Status of last command execution.
\$CLI.USER	Username for the user who is executing this CLI.
\$CLI.SESSION_ID	An identifier for a session. This identifier is available for the roll-back event when a device or user times out.
\$CLI.SESSION_TYPE	Type of session of the user.
\$EVENT.NAME	This is the event that triggered this profile.
\$EVENT.TIME	Time this event occurred. The time is in seconds since epoch.
\$EVENT.TIMER_TYPE	Type of timer, which is <i>periodic</i> or <i>non_periodic</i> .
\$EVENT.TIMER_NAME	Name of the timer that the Universal Port is invoking.
\$EVENT.TIMER_LATE_SECS	Time difference between when the timer fired and when the actual shell was run in seconds. ^a
\$EVENT.PROFILE	Name of the profile that is being run currently.

a. In ExtremeXOS Release 12.0, this variable was named \$EVENT.TIMER_DELTA_SECS.

User Profile Variables. Table 34 shows the variables available to user profiles.

Table 34: User Profile Variables

Variable Syntax	Definition
\$EVENT.USERNAME	Name of user authenticated. This is a string with the MAC address for MAC-based user-login.
\$EVENT.NUMUSERS	Number of authenticated supplicants on this port after this event occurred.
	 NOTE For user-authenticated events, the initial value of this variable is 0. For user unauthenticated events, the initial value is 1.
\$EVENT.USER_MAC	MAC address of the user.
\$EVENT.USER_PORT	Port associated with this event.
\$EVENT.USER_VLAN	VLAN associated with this event or user.
\$EVENT.USER_ALL_VLANS	When a user is authenticated to multiple VLANs, this variable includes all VLANs for which the user is authenticated.
\$EVENT.USER_IP	IP address of the user if applicable. Otherwise, this variable is blank.

Device Detect Profile Variables. Table 35 shows the variables available to device detect profiles.

Table 35: Device Profile Variables

Variable Syntax	Definition
\$EVENT.DEVICE	Device identification string. Possible values for EVENT.DEVICE are: AVAYA_PHONE, GEN_TEL_PHONE, ROUTER, BRIDGE, REPEATER, WLAN_ACCESS_PT, DOCSIS_CABLE_SER, STATION_ONLY and OTHER. These strings correspond to the devices that the LLDP application recognizes and reports to the Universal Port management application.
\$EVENT.DEVICE_IP	The IP address of the device (if available). Blank if not available.
\$EVENT.DEVICE_MAC	The MAC address of the device (if available). Blank if not available.
\$EVENT.DEVICE_POWER	The power of the device in milliwatts (if available). Blank if not available.
\$EVENT.DEVICE_MANUFACTURE R_NAME	The manufacturer of the device.
\$EVENT.DEVICE_MODEL_NAME	Model name of the device.
\$EVENT.USER_PORT	Port associated with the event.

Event Profile Variables. Table 36 shows the variables available to event profiles.

Table 36: Event Profile Variables

Variable Syntax	Definition
\$EVENT.NAME	The event message.
\$EVENT.LOG_DATE	The event date.
\$EVENT.LOG_TIME	The event time.
\$EVENT.LOG_ COMPONENT_ SUBCOMPONENT	The component and subcomponent affected by the event as it appears in the <code>show log components</code> command display.
\$EVENT.LOG_EVENT	The event condition as it appears in the <code>show log events</code> command display.
\$EVENT.LOG_FILTER_ NAME	The EMS filter that triggered the profile.
\$EVENT.LOG_SEVERITY	The event severity level defined in EMS.
\$EVENT.LOG_MESSAGE	The event message with arguments listed in the format %1%.
\$EVENT.LOG_PARAM_0 to \$EVENT.LOG_PARAM_9	Event arguments 0 to 9.

Collecting Information from Supplicants

A supplicant is a device such as a VoIP phone or workstation that connects to the switch port and requests network services. As described in [Chapter 8, “LLDP,”](#) LLDP is a protocol that can be used to collect information about device capabilities from attached devices or supplicants.

To use Universal Port with LLDP, you must enable LLDP on the port.

**NOTE**

Avaya and Extreme Networks have developed a series of extensions for submission to the standards consortium for inclusion in a later version of the LLDP-MED standard:

- Avaya Power conservation mode
- Avaya file server
- Avaya call server

The following is an example of information provided through LLDP about an IP phone:

```
LLDP Port 1 detected 1 neighbor
Neighbor: (5.1)192.168.10.168/00:04:0D:E9:AF:6B, age 7 seconds
- Chassis ID type: Network address (5); Address type: IPv4 (1)
  Chassis ID      : 192.168.10.168
- Port ID type: MAC address (3)
  Port ID        : 00:04:0D:E9:AF:6B
- Time To Live: 120 seconds
- System Name: "AVAE9AF6B"
- System Capabilities : "Bridge, Telephone"
  Enabled Capabilities: "Bridge, Telephone"
- Management Address Subtype: IPv4 (1)
  Management Address      : 192.168.10.168
  Interface Number Subtype : System Port Number (3)
  Interface Number        : 1
  Object ID String        : "1.3.6.1.4.1.6889.1.69.1.13"
- IEEE802.3 MAC/PHY Configuration/Status
  Auto-negotiation        : Supported, Enabled (0x03)
  Operational MAU Type    : 100BaseTXFD (16)
- MED Capabilities: "MED Capabilities, Network Policy, Inventory"
  MED Device Type : Endpoint Class III (3)
- MED Network Policy
  Application Type : Voice (1)
  Policy Flags     : Known Policy, Tagged (0x1)
  VLAN ID         : 0
  L2 Priority      : 6
  DSCP Value      : 46
- MED Hardware Revision: "4625D01A"
- MED Firmware Revision: "b25d01a2_7.bin"
- MED Software Revision: "a25d01a2_7.bin"
- MED Serial Number: "061622014487"
- MED Manufacturer Name: "Avaya"
- MED Model Name: "4625"
- Avaya/Extreme Conservation Level Support
  Current Conservation Level: 0
  Typical Power Value       : 7.4 Watts
  Maximum Power Value       : 9.8 Watts
  Conservation Power Level  : 1=7.4W
- Avaya/Extreme Call Server(s): 192.168.10.204
- Avaya/Extreme IP Phone Address: 192.168.10.168 255.255.255.0
  Default Gateway Address    : 192.168.10.254
- Avaya/Extreme CNA Server: 0.0.0.0
- Avaya/Extreme File Server(s): 192.168.10.194
- Avaya/Extreme IEEE 802.1q Framing: Tagged
```

**NOTE**

LLDP is tightly integrated with IEEE 802.1x authentication at edge ports. When used together, LLDP information from authenticated end point devices is trustable for automated configuration purposes. This tight integration between 802.1x and LLDP protects the network from automation attacks.

Supplicant Configuration Parameters

As described in [Chapter 8, “LLDP,”](#) LLDP is a protocol that can be used to configure attached devices or supplicants. The following LLDP parameters are configurable on the switch ports when device-detect profiles execute:

- VLAN Name
- Port VLAN ID
- Power Conservation Mode
- Avaya File Server
- Avaya Call server
- 802.1Q Framing

Universal Port Configuration Overview

Because Universal Port operates with multiple ExtremeXOS software features and can operate with multiple third-party products, Universal Port configuration can require more than just the creation of profiles and triggers. No single overview procedure can cover all the possible Universal Port configurations. The following sections provide overviews of the following common types of Universal Port configurations:

- [Device-Detect Configurations on page 341](#)
- [User-Authentication Configurations on page 342](#)
- [Time-of-Day Configurations on page 343](#)
- [EMS-Event Configurations on page 343](#)

Device-Detect Configurations

A Universal Port device-detect configuration requires only a switch and supplicants. If PoE devices will connect to the switch, the switch should support PoE. Supplicants should support LLDP in the applicable software or firmware.

**NOTE**

To support supplicant configuration, you might consider adding a DHCP server to your network.

Use the following procedure to configure Universal Port for device detection:

- 1 Create a device-detect profile as described in [“Creating and Configuring New Profiles” on page 345.](#)
- 2 Create a device-undetected profile as described in [“Creating and Configuring New Profiles” on page 345.](#)

- 3 Assign the device-detect profile to the edge ports as described in “[Configuring a Device Event Trigger](#)” on page 345.
- 4 Assign the device-undetected profile to the edge ports as described in “[Configuring a Device Event Trigger](#)” on page 345.
- 5 Verify that correct profiles are assigned to correct ports by entering the following command:

```
show upm events <event-type>
```
- 6 Enable LLDP message advertisements on the ports that are configured for device-detect profiles as described in [Chapter 8, “LLDP.”](#)
- 7 Test profile operation as described in “[Verifying a Universal Port Profile](#)” on page 349.

User-Authentication Configurations

A Universal Port user-authenticate configuration requires the following components:

- An Extreme Networks switch, which might need to include PoE support.
- RADIUS server for user authentication and VSA transmission.
- Supplicants that support the authentication method you select. LLDP support is recommended, but is optional when MAC address authentication is used.



NOTE

To support supplicant configuration, you might consider adding a DHCP server to your network. For VoIP applications, you can use a TFTP server and a call server to provide for additional supplicant configuration.

Use the following procedure to configure Universal Port for user login:

- 1 Configure the RADIUS server as described in [Chapter 23, “Security.”](#). The configuration should include the following:
 - User ID and password for RADIUS clients.
 - Extreme Networks custom VSAs.
 - Addition of the edge switch as a RADIUS client.
- 2 Create a user-authenticate profile as described in “[Creating and Configuring New Profiles](#)” on page 345.
- 3 Create a user-unauthenticate profile as described in “[Creating and Configuring New Profiles](#)” on page 345.
- 4 Assign the user-authenticate profile to the edge ports as described in “[Configuring a User Login or Logout Event Trigger](#)” on page 346.
- 5 Assign the user-unauthenticate profile to the edge ports as described in “[Configuring a User Login or Logout Event Trigger](#)” on page 346.
- 6 Configure network login on the edge switch as described in [Chapter 21, “Network Login.”](#)
- 7 Configure the edge switch as a RADIUS client as described in [Chapter 23, “Security.”](#)
- 8 Verify that correct profiles are assigned to correct ports by entering the following command:

```
show upm events <event-type>
```
- 9 Enable LLDP message advertisements on the ports that are configured for device-detect profiles as described in [Chapter 8, “LLDP.”](#)
- 10 Test profile operation as described in “[Verifying a Universal Port Profile](#)” on page 349.

Time-of-Day Configurations

To configure Universal Port to use a time-of-day profile, use the following procedure:

- 1 Create a profile as described in [“Creating and Configuring New Profiles” on page 345](#).
- 2 Create and configure a timer as described in [“Configuring a Universal Port Timer” on page 346](#).
- 3 Create the timer trigger and attach it to the profile as described in [“Configuring a Timer Trigger” on page 346](#).

EMS-Event Configurations

To configure Universal Port to use an EMS-event profile, use the following procedure:

- 1 Create the EMS-Event profile as described in [“Creating and Configuring New Profiles” on page 345](#).
- 2 Create and configure an event filter to identify the trigger event as described in [“Creating an EMS Event Filter” on page 346](#).
- 3 Create the event trigger and attach it to the profile and filter as described in [“Configuring an EMS Event Trigger” on page 347](#).
- 4 Enable the event trigger as described in [“Enabling and Disabling an EMS Event Trigger” on page 347](#).

Using Universal Port in an LDAP or Active Directory Environment

The RADIUS server can operate in proxy mode with information stored in a central directory service such as LDAP or Active Directory. This proxy mode is configured between the RADIUS server and the central directory service. Once configured, supplicants can be authenticated from the central directory service. For more information, see the following:

- [“Setting Up Open LDAP” in Chapter 23, “Security”](#)
- RADIUS server product documentation
- Product documentation for your central directory service

Configuring Universal Port Profiles and Triggers

You can configure both static and dynamic profiles using the command line interface (CLI) or the Ridgeline Universal Port Manager. This section describes the following configuration tasks using the CLI:

- [Creating and Configuring New Profiles on page 345](#)
- [Editing an Existing Profile on page 345](#)
- [Configuring a Device Event Trigger on page 345](#)
- [Configuring a User Login or Logout Event Trigger on page 346](#)
- [Configuring a Universal Port Timer on page 346](#)
- [Configuring a Timer Trigger on page 346](#)
- [Creating an EMS Event Filter on page 346](#)
- [Configuring an EMS Event Trigger on page 347](#)
- [Enabling and Disabling an EMS Event Trigger on page 347](#)

- [Unconfiguring a Timer on page 347](#)



NOTE

In the CLI, “upm” is used as an abbreviation for the Universal Port feature.

Creating and Configuring New Profiles

When you create and configure a new profile, you are basically writing a script within a profile that can be triggered by system events. For more information on the rules, commands, and variables that apply to profiles, see “[Profile Configuration Guidelines](#)” on page 334.

To create and configure a new profile, enter the following command:

```
configure upm profile <profile-name> maximum execution-time <seconds>
```

After you enter the command, the switch prompts you to add command statements to the profile as shown in the following example:

```
X450e-24p.3 # create upm profile detect-voip
Start typing the profile and end with a . as the first and the only character on a
line.
Use - edit upm profile <name> - for block mode capability

create log message Starting_Script_DETECT-voip
set var callServer 192.168.10.204
set var fileServer 192.168.10.194
set var voiceVlan voice
set var CleanupProfile CleanPort
set var sendTraps false
#
.
X450e-24p.4 #
```

The example above creates a log entry and sets some variables, but it is not complete. This example shows that after you enter the `create upm profile` command, you can enter system commands. When you have finished entering commands, you can exit the profile creation mode by typing the period character at the start of a line and pressing <Enter>.

Editing an Existing Profile

To edit an existing profile, enter the following command:

```
edit upm profile <profile-name>
```

Configuring a Device Event Trigger

There are two types of device event triggers, which are named as follows in the CLI: `device-detect` and `device-undetected`. When you configure a device event trigger, you assign one of the two device event trigger types to a profile and specify the ports to which the triggered profile applies. To configure a device event trigger, use the following command:

```
configure upm event <upm-event> profile <profile-name> ports <port_list>
```

Replace `<upm-event>` with one of the device event trigger types: `device-detect` or `device-undetected`.

Configuring a User Login or Logout Event Trigger

There are two types of user event triggers, which are named as follows in the CLI: `user-authenticate` and `user-unauthenticated`. When you configure a user event trigger, you assign one of the two user event trigger types to a profile and specify the ports to which the triggered profile applies. To configure a user event trigger, use the following command:

```
configure upm event <upm-event> profile <profile-name> ports <port_list>
```

Replace `<upm-event>` with one of the device event trigger types: `user-authenticate` or `user-unauthenticated`.

Configuring a Universal Port Timer

To configure a Universal Port timer, you must complete two steps:

- 1 Create the timer.
- 2 Configure the timer.

To create the timer, use the following command:

```
create upm timer <timer-name>
```

To configure the timer, use the following commands:

```
configure upm timer <timer-name> after <time-in-secs> {every <seconds>}
```

```
configure upm timer <timer-name> at <month> <day> <year> <hour> <min> <secs> {every <seconds>}
```

Configuring a Timer Trigger

When you configure a timer trigger, you assign a configured timer to a profile. When the configured time arrives, the switch executes the profile.

To configure a timer trigger, use the following command:

```
configure upm timer <timerName> profile <profileName>
```

Replace `<timerName>` with the timer name and `<profileName>` with the profile name.

Creating an EMS Event Filter

An EMS event filter identifies an event that can be used to trigger a profile. To create an EMS event filter, use the following procedure:

- 1 Create a log filter to identify the event using the following command:

```
create log filter <name> {copy <filter name>}
```

- 2 Configure the log filter using the following commands:

```
configure log filter <name> [add | delete] {exclude} events [<event-condition> | [all | <event-component>] {severity <severity> {only}}]
```

```
configure log filter <name> [add | delete] {exclude} events [<event-condition> | [all | <event-component>] {severity <severity> {only}}] [match | strict-match] <type> <value>
```

Configuring an EMS Event Trigger

When you configure an EMS event trigger, you identify an EMS filter that defines the event and a profile that runs when the event occurs. To configure an EMS event-triggered profile, use the following procedure:

- 1 Create a log target to receive the event notification using the following command:

```
create log target upm {<upm_profile_name>}
```

- 2 Configure the log target to specify a filter and any additional parameters that define the event with the following commands:

```
configure log target upm {<upm_profile_name>} filter <filter-name> {severity  
[[<severity>] {only}}}
```

```
configure log target upm {<upm_profile_name>} match {any | <regex>}
```

Enabling and Disabling an EMS Event Trigger

When you configure an EMS event trigger, it is disabled. To enable an EMS event trigger or disable a previously enabled trigger, use the following commands:

```
enable log target upm {<upm_profile_name>}
```

```
disable log target upm {<upm_profile_name>}
```

Unconfiguring a Timer

To unconfigure a timer, use the following command:

```
unconfigure upm timer <timerName> profile <profileName>
```

Managing Profiles and Triggers

This section describes the following tasks:

- [Manually Executing a Static or Dynamic Profile on page 348](#)
- [Displaying a Profile on page 348](#)
- [Displaying Timers on page 348](#)
- [Displaying Universal Port Events on page 348](#)
- [Displaying Profile History on page 348](#)
- [Verifying a Universal Port Profile on page 349](#)
- [Handling Profile Execution Errors on page 349](#)
- [Disabling and Enabling a Profile on page 349](#)
- [Deleting a Profile on page 350](#)
- [Deleting a Timer on page 350](#)
- [Deleting an EMS Event Trigger on page 350](#)

Manually Executing a Static or Dynamic Profile

Profiles can be run from the command line interface by configuring the system to run as it would when the trigger events happen. This facility is provided to allow you to test how the system behaves when the actual events happen. The actual configuration is applied to the switch when the profile is run.

To manually execute a profile, use the following command:

```
run upm profile <profile-name> {event <event-name>} {variables <variable-string>}
```

Example:

```
run upm profile afterhours
```

If the `variables` keyword is not present, but an events variable is specified, the user is prompted for various environment variables appropriate for the event, including the VSA string for user authentication.



NOTE

Variables are not validated for correct syntax.

Displaying a Profile

To display a profile, enter the following command:

```
show upm profile <name>
```

Displaying Timers

To display a list of timers and associated timer information, enter the following command:

```
show upm timers
```

Displaying Universal Port Events

You can display a list of events that relate to one of the following trigger types:

- device-detect
- device-undetected
- user-authenticate
- user-unauthenticated

To display a list of Universal Port events for one of the above triggers, enter the following command:

```
show upm events <event-type>
```

Replace `<event-type>` with one of the trigger types listed above.

Displaying Profile History

To display a list of triggered events and associate event data, enter one of the following commands:

```
show upm history {profile <profile-name> | event <upm-event> | status [pass | fail] |
timer <timer-name> | detail}
```

```
show upm history exec-id <number>
```

Verifying a Universal Port Profile

To verify a Universal Port profile configuration, trigger the profile and verify that it works properly. Trigger the profile based on the trigger type as follows:

- Device triggers: plug in the device
- Authentication triggers: authenticate a device or user
- Timer triggers: temporarily configure the timer for an approaching time
- EMS event triggers: reproduce the event to which the trigger responds

You can use the commands described earlier in this section to view information about the profile and how it behaves. Because Universal Port works with multiple switch features, you might want to enter commands to examine the configuration of those features. The following commands are an example of some of the commands that can provide additional information about profile operation:

```
show lldp
show lldp neighbors
show log
show netlogin
```

Handling Profile Execution Errors

To conserve resources, the switch stores only the last execution log for the profile that resulted in an error.

Use the following command to see a tabular display showing the complete history of the last 100 profiles run:

```
show upm history {profile <profile-name> | event <upm-event> | status [pass | fail] |
timer <timer-name> | detail}
```

Use the `detail` keyword to display the actual executions that happened when the profile was run.

Use the following command to display a specific execution that was run:

```
show upm history exec-id <number>
```

Select the `exec-id` number from the list in the tabular display.

Disabling and Enabling a Profile

Universal Port profiles are automatically enabled when they are created. To disable a profile or enable a previously disabled profile, use the following commands:

```
disable upm profile <profile-name>
```

```
enable upm profile <profile-name>
```

Deleting a Profile

To delete a profile, enter the following command:

```
delete upm profile <profile-name>
```

Deleting a Timer

To delete a timer, enter the following command:

```
delete upm timer <timer-name>
```

Deleting an EMS Event Trigger

To delete an EMS event trigger, enter the following command:

```
delete log target upm {<upm_profile_name>}
```

Sample Universal Port Configurations

This section provides the following examples:

- [Sample MAC Tracking Profile on page 350](#)
- [Universal Port Handset Provisioning Module Profiles on page 356](#)
- [Sample Static Profiles on page 360](#)
- [Sample Configuration with Device-Triggered Profiles on page 363](#)
- [Sample Configuration with User-Triggered Profiles on page 365](#)
- [Sample Profile with QoS Support on page 368](#)
- [Sample Event Profile on page 369](#)
- [Sample Configuration for Generic VoIP LLDP on page 371](#)
- [Sample Configuration for Generic VoIP 802.1x on page 372](#)
- [Sample Configuration for Avaya VoIP 802.1x on page 373](#)
- [Sample Configuration for a Video Camera on page 375](#)

Sample MAC Tracking Profile

The example in this section shows how to create a profile that takes action based on the MAC tracking feature. When the MAC tracking feature detects a MAC move in a VLAN, the MAC tracking feature generates an EMS log, which then triggers a profile. The following sections provide information for this example:

- [Switch Configuration on page 351](#)
- [MAC Tracking EMS Log Message on page 351](#)
- [Profile Configuration on page 351](#)
- [Policy File Configuration on page 352](#)
- [Console Logs on page 352](#)

**NOTE**

You can also use the Identity Management feature to configure ports in response to MAC device detection events. For more information, see [Chapter 22, "Identity Management."](#)

Switch Configuration

The general switch configuration is as follows:

```
#Vlan config
create vlan v1
configure v1 add ports 1:17-1:18
configure vlan v1 ipadd 192.168.10.1/24

#mac tracking config
create fdb mac-tracking entry 00:01:02:03:04:01
create fdb mac-tracking entry 00:01:02:03:04:02
create fdb mac-tracking entry 00:01:02:03:04:03
create fdb mac-tracking entry 00:01:02:03:04:04
create fdb mac-tracking entry 00:01:02:03:04:05

#Log filter configuration
create log filter macMoveFilter
configure log filter "macMoveFilter" add events "FDB.MACTracking.MACMove"

#Meter configuration for ingress /egress rate limit
create meter m1
configure meter m1 peak-rate 250 mbps
create meter m2
configure meter m2 peak-rate 500 mbps
```

MAC Tracking EMS Log Message

The MAC tracking feature produces the following EMS log message and message parameters:

```
The MAC address %0% on VLAN '%1%' has moved from port %2% to port %3%
EVENT.LOG_PARAM_1 "vlan name"
EVENT.LOG_PARAM_2 "source port"
EVENT.LOG_PARAM_3 "moved port"
```

Profile Configuration

The profile is configured as follows:

```
create upm profile macMove ;# editor
enable cli scripting
create access-list dacl1 "source-address 192.168.10.0/24 " "permit ;count dacl1"
create access-list dacl2 "source-address 192.168.11.0/24 " "permit ;count dacl2"
create access-list dacl3 "source-address 192.168.15.0/24 " "deny ;count dacl3"
create access-list dacl4 "source-address 192.168.16.0/24 " "deny ;count dacl4"
create access-list dacl5 "source-address 192.168.17.0/24 " "deny ;count dacl5"
configure access-list add dacl1 first ports $(EVENT.LOG_PARAM_3)
configure access-list add dacl2 first ports $(EVENT.LOG_PARAM_3)
configure access-list add dacl3 first ports $(EVENT.LOG_PARAM_3)
```

```

configure access-list add dacl4 first ports $(EVENT.LOG_PARAM_3)
configure access-list add dacl5 first ports $(EVENT.LOG_PARAM_3)
conf access-list ingress_limit vlan v1
conf access-list ingress_limit ports $(EVENT.LOG_PARAM_3)
conf access-list egress_limit any ;# enter . for SAVE/EXIT

log target configuration
create log target upm "macMove"
configure log target upm "macMove" filter "macMoveFilter"
enable log target upm "macMove"

```

Policy File Configuration

This example uses the following two policy files:

```

Ingress rate limit (ingress_limit.pol)
=====

```

```

entry ingress {
    if {
        ethernet-source-address 00:AA:00:00:00:01;
        ethernet-destination-address 00:BB:00:00:00:01;

    } then {
        Meter m1;
        count c1;
    }
}

```

```

Egress QoS (egress_limit.pol)
=====

```

```

entry egress {
    if {
        ethernet-source-address 00:BB:00:00:00:01;
        ethernet-destination-address 00:AA:00:00:00:01;

    } then {
        qosprofile qp2;
        count c2;
    }
}

```

Console Logs

The following show commands display the switch configuration:

```
* (debug) BD-12804.7 # show log con fil
```

```

Log Filter Name: DefaultFilter
I/
E Component    SubComponent Condition          Severity
- - - - -
I All
*****

```

```
Log Filter Name: macMoveFilter
I/                                         Severity
E Component   SubComponent Condition          CEWNISVD
-----
I FDB         MACTracking  MACMove           ---N---
```

```
* (debug) BD-12804.14 # sh fdb mac-tracking configuration
SNMP trap notification : Disabled
MAC address tracking table (5 entries):
00:01:02:03:04:01
00:01:02:03:04:02
00:01:02:03:04:03
00:01:02:03:04:04
00:01:02:03:04:05
```

```
* (debug) BD-12804.15 #
```

```
* (debug) BD-12804.27 # show meter
```

```
-----
Name      Committed Rate(Kbps) Peak Rate(Kbps)   Burst Size(Kb)
-----
m1                --          250000           --
m2                --          500000           --
```

```
Total number of Meter(s) : 2
```

```
* (debug) BD-12804.28 #
```

The following show commands display the switch status after a MAC address move:

```
=====
(debug) BD-12804.7 # show log
05/14/2009 11:33:54.89 <Noti:ACL.Policy.bind> MSM-A:
Policy:bind:egress_limit:vlan*:port*:
05/14/2009 11:33:54.89 <Info:pm.config.loaded> MSM-A: Loaded Policy: egress_limit
number of entries 1
05/14/2009 11:33:54.89 <Info:pm.config.openingFile> MSM-A: Loading policy egress_limit
from file /config/egress_limit.pol
05/14/2009 11:33:54.89 <Noti:ACL.Policy.bind> MSM-A:
Policy:bind:ingress_limit:vlan*:port:1:18:
05/14/2009 11:33:54.88 <Noti:ACL.Policy.bind> MSM-A:
Policy:bind:ingress_limit:vlan:v1:port*:
05/14/2009 11:33:54.87 <Info:pm.config.loaded> MSM-A: Loaded Policy: ingress_limit
number of entries 1
05/14/2009 11:33:54.87 <Info:pm.config.openingFile> MSM-A: Loading policy
ingress_limit from file /config/ingress_limit.pol
05/14/2009 11:33:54.72 <Noti:UPM.Msg.upmMsgExshLaunch> MSM-A: Launched profile macMove
for the event log-message
```

A total of 8 log messages were displayed.

```
* (debug) BD-12804.8 # show upm history
```

```
-----
Exec   Event/                               Profile           Port Status Time Launched
```

```

Id      Timer/ Log filter
-----
1      Log-Message(macMoveF macMove      --- Pass      2009-05-14 11:33:54
-----

```

Number of UPM Events in Queue for execution: 0

* (debug) BD-12804.9 # sh upm history detail

UPM Profile: macMove

Event: Log-Message(macMoveFilter)

Profile Execution start time: 2009-05-14 11:33:54

Profile Execution Finish time: 2009-05-14 11:33:54

Execution Identifier: 1 Execution Status: Pass

Execution Information:

```

1 # enable cli scripting
2 # configure cli mode non-persistent
3 # set var EVENT.NAME LOG_MESSAGE
4 # set var EVENT.LOG_FILTER_NAME "macMoveFilter"
5 # set var EVENT.LOG_DATE "05/14/2009"
6 # set var EVENT.LOG_TIME "11:33:54.72"
7 # set var EVENT.LOG_COMPONENT_SUBCOMPONENT "FDB.MACTracking"
8 # set var EVENT.LOG_EVENT "MACMove"
9 # set var EVENT.LOG_SEVERITY "Notice"
10 # set var EVENT.LOG_MESSAGE "The MAC address %0% on VLAN '%1%' has moved from port
%2% to port %3%"
11 # set var EVENT.LOG_PARAM_0 "00:01:02:03:04:05"
12 # set var EVENT.LOG_PARAM_1 "v1"
13 # set var EVENT.LOG_PARAM_2 "1:17"
14 # set var EVENT.LOG_PARAM_3 "1:18"
15 # set var EVENT.PROFILE macMove
16 # enable cli scripting
17 # create access-list dacl1 "source-address 192.168.10.0/24 " "permit ;count dacl1"
18 # create access-list dacl2 "source-address 192.168.11.0/24 " "permit ;count dacl2"
19 # create access-list dacl3 "source-address 192.168.15.0/24 " "deny ;count dacl3"
20 # create access-list dacl4 "source-address 192.168.16.0/24 " "deny ;count dacl4"
21 # create access-list dacl5 "source-address 192.168.17.0/24 " "deny ;count dacl5"
22 # configure access-list add dacl1 first ports $(EVENT.LOG_PARAM_3)
done!
23 # configure access-list add dacl2 first ports $(EVENT.LOG_PARAM_3)
done!
24 # configure access-list add dacl3 first ports $(EVENT.LOG_PARAM_3)
done!
25 # configure access-list add dacl4 first ports $(EVENT.LOG_PARAM_3)
done!
26 # configure access-list add dacl5 first ports $(EVENT.LOG_PARAM_3)
done!
27 # conf access-list ingress_limit vlan v1
done!
28 # conf access-list ingress_limit ports $(EVENT.LOG_PARAM_3)
done!
29 # conf access-list egress_limit any
done!
-----

```

Number of UPM Events in Queue for execution: 0

* (debug) BD-12804.10 #

* (debug) BD-12804.7 # show fdb mac-tracking statistics

MAC Tracking Statistics Thu May 14 11:41:10 2009

MAC Address	Add events	Move events	Delete events
00:01:02:03:04:01	0	0	0
00:01:02:03:04:02	0	0	0
00:01:02:03:04:03	0	0	0
00:01:02:03:04:04	0	0	0
00:01:02:03:04:05	1	1	0

=====
0->Clear Counters U->page up D->page down ESC->exit

(debug) BD-12804.5 # show access-list

Vlan Name	Port	Policy Name	Dir	Rules	Dyn Rules
*	*	egress_limit	ingress	1	0
*	1:18	ingress_limit	ingress	1	5
v1	*	ingress_limit	ingress	1	0

* (debug) BD-12804.6 # show access-list dynamic

Dynamic Rules: ((*)- Rule is non-permanent)

(*)dac11 Bound to 1 interfaces for application Cli
 (*)dac12 Bound to 1 interfaces for application Cli
 (*)dac13 Bound to 1 interfaces for application Cli
 (*)dac14 Bound to 1 interfaces for application Cli
 (*)dac15 Bound to 1 interfaces for application Cli
 (*)hclag_arp_0_4_96_1e_32_80 Bound to 0 interfaces for application

HealthCheckLAG

* (debug) BD-12804.7 #

* (debug) BD-12804.7 #

=====

Universal Port Handset Provisioning Module Profiles

The Universal Port Handset Provisioning Module provides the following profiles:

- [Device-Triggered Generic Profile on page 356](#)
- [Authentication-Triggered Generic Profile on page 357](#)
- [Authentication-Triggered Avaya Profile on page 359](#)

Device-Triggered Generic Profile

This is a template for configuring network parameters for VoIP phone support without 802.1x authentication. The profile is triggered after an LLDP packet is detected on the port.



NOTE

The MetaData information is used by the Ridgeline to create a user-friendly interface to modify the variables. You can ignore the MetaData while using the CLI.

```

*****
# Last Updated: April 11, 2007
# Tested Phones: Avaya 4610, 4620, 4625
# Requirements: LLDP capable devices
*****
# @MetaDataStart
# @ScriptDescription "This is a template for configuring network parameters for VoIP
phones support LLDP but without authentication. The module is triggered through the
detection of an LLDP packet on the port. The following network side configuration is
done: enable SNMP traps, QoS assignment, adjust POE reservation values based on device
requirements, add the voiceVlan to the port as tagged. "
# @VariableFieldLabel "Voice VLAN name"
set var voicevlan voiceavaya
# @VariableFieldLabel "Send trap when LLDP event happens (true or false)"
set var sendTraps false
# @VariableFieldLabel "Set QoS Profile (true or false)"
set var setQuality false
# @MetaDataEnd
#
if (!$match($EVENT.NAME,DEVICE-DETECT)) then
    create log message Starting_LLDP_Generic_Module_Config
# VoiceVLAN configuration
configure vlan $voicevlan add port $EVENT.USER_PORT tagged

#SNMP Trap
    if (!$match($sendTraps,true)) then
        create log message Config_SNMP_Traps
        enable snmp traps lldp ports $EVENT.USER_PORT
        enable snmp traps lldp-med ports $EVENT.USER_PORT
    else
        disable snmp traps lldp ports $EVENT.USER_PORT
        disable snmp traps lldp-med ports $EVENT.USER_PORT
    endif
#Link Layer Discovery Protocol-Media Endpoint Discover
create log message Config_LLDP
configure lldp port $EVENT.USER_PORT advertise vendor-specific med capabilities

```

```

configure lldp port $EVENT.USER_PORT advertise vendor-specific dot1 vlan-name vlan
$voicevlan
configure lldp port $EVENT.USER_PORT advertise vendor-specific med policy application
voice vlan $voicevlan dscp 46
configure lldp port $EVENT.USER_PORT advertise vendor-specific med power-via-mdi

#Configure POE settings per device requirements
create log message Config_POE
configure inline-power operator-limit $EVENT.DEVICE_POWER ports $EVENT.USER_PORT

#QoS Profile
  if (!$match($setQuality,true)) then
    create log message Config_QOS
    configure port $EVENT.USER_PORT qosprofile qp7
  endif
endif

if (!$match($EVENT.NAME,DEVICE-UNDETECT) && $match($EVENT.DEVICE_IP,0.0.0.0)) then
  create log message Starting_LLDP_Generic_UNATUH_Module_Config
  if (!$match($sendTraps,true)) then
    create log message UNConfig_SNMP_Traps
    disable snmp traps lldp ports $EVENT.USER_PORT
    disable snmp traps lldp-med ports $EVENT.USER_PORT
  endif
  create log message UNConfig_LLDP
  unconfig lldp port $EVENT.USER_PORT
  if (!$match($setQuality,true)) then
    create log message UNConfig_QOS
    unconfig qosprofile ports $EVENT.USER_PORT
  endif
  unconfig inline-power operator-limit ports $EVENT.USER_PORT
endif

if (!$match($EVENT.NAME,DEVICE-UNDETECT) && !$match($EVENT.DEVICE_IP,0.0.0.0)) then
  create log message DoNothing_0.0.0.0
  create log message $EVENT.TIME
endif
create log message End_LLDP_Generic_Module_Config

```

Authentication-Triggered Generic Profile

This profile has been created for phones that support an authentication protocol. This profile assumes that the phone does not support LLDP and is provisioned using DHCP options.

This is a template for configuring network parameters for 802.1x authenticated devices. The module is triggered through successful authentication or unauthentication of the device.

```

#*****
# Last Updated: April 11, 2007
# Tested Phones: Avaya 4610, 4620, 4625
# Requirements: 802.1x capable devices, netlogin configured and enabled on deployment
ports
#*****
# @MetaDataStart

```

```

# @ScriptDescription "This is a template for configuring network parameters for 802.1x
authenticated devices. The module is triggered through successful authentication of
the device. The following network side configuration is done: QoS assignment and
enables DOS protection. When used with IP phones, phone provisioning is done through
DHCP options."
# @Description "VLAN name to add to port"
set var vlan1 voiceavaya
# @VariableFieldLabel "Set QoS Profile (yes or no)"
set var setQuality yes
# @Description "QoS Profile (0-100)"
set var lowbw 50
# @VariableFieldLabel "QoS MAX Bandwidth (0-100)"
set var highbw 100
# @VariableFieldLabel "Enable Denial of Service Protection (yes or no)"
set var dosprotection yes
# @MetaDataEnd

#####
# Start of USER-AUTHENTICATE block
#####
if (!$match($EVENT.NAME,USER-AUTHENTICATED)) then

#####
#QoS Profile
#####
# Adds a QoS profile to the port
  if (!$match($setQuality,yes)) then
    create log message Config_QoS
    configure port $EVENT.USER_PORT qosprofile qp7
    configure qosprofile qp7 minbw $lowbw maxbw $highbw ports $EVENT.USER_PORT
  endif
#
#####
#Security Configurations
#####
create log message Applying_Security_Limits
# enables Denial of Service Protection for the port
  if (!$match($dosprotection,yes)) then
    enable dos-protect
    create log message DOS_enabled
  endif
#
endif
#####
# End of USER-AUTHENTICATE block
#####
#
#
#####
# Start of USER-UNAUTHENTICATE block
#####
if (!$match($EVENT.NAME,USER-UNAUTHENTICATED)) then
  create log message Starting_8021x_Generic_UNATUH_Module_Config
  if (!$match($setQuality,yes)) then
    create log message UNConfig_QoS
    unconfig qosprofile ports $EVENT.USER_PORT
  endif
endif

```

```

endif
unconfig inline-power operator-limit ports $EVENT.USER_PORT
endif
#####
# End of USER-UNAUTHENTICATE block
#####
create log message End_802_1x_Generic_Module_Config

```

Authentication-Triggered Avaya Profile

This script has been created for Avaya phones that support both 802.1x authentication and LLDP. Instead of using DHCP options, the phone is provisioned using LLDP parameters developed jointly by Extreme Networks and Avaya.

```

#####
# Last Updated: April 11, 2007
# Tested Phones: SW4610, SW4620
# Requirements: 802.1x authentication server, VSA 203 and VSA 212 from authentication
server. QP7 defined on the switch
#####
# @MetaDataStart
# @ScriptDescription "This is a template for configuring LLDP capable Avaya phones
using the authentication trigger. This module will provision the phone with the
following parameters: call server, file server, dot1q, dscp, power. Additionally the
following network side configuration is done: enable SNMP traps and QoS assignment"
# @VariableFieldLabel "Avaya phone call server IP address"
set var callserver 192.45.95.100
# @VariableFieldLabel "Avaya phone file server IP address"
set var fileserver 192.45.10.250
# @VariableFieldLabel "Send trap when LLDP event happens (true or false)"
set var sendTraps true
# @VariableFieldLabel "Set QoS Profile (true or false)"
set var setQuality true
# @MetaDataEnd

#
if (!$match($EVENT.NAME,USER-AUTHENTICATED)) then
  create log message Starting_Avaya_VOIP_802.1x_AUTH_Module_Config
  if (!$match($sendTraps,true)) then
    enable snmp traps lldp ports $EVENT.USER_PORT
    enable snmp traps lldp-med ports $EVENT.USER_PORT
  else
    disable snmp traps lldp ports $EVENT.USER_PORT
    disable snmp traps lldp-med ports $EVENT.USER_PORT
  endif
  enable lldp port $EVENT.USER_PORT
  configure lldp port $EVENT.USER_PORT advertise vendor-specific dot1 vlan-name
  configure lldp port $EVENT.USER_PORT advertise vendor-specific avaya-extreme call-
server $callserver
  configure lldp port $EVENT.USER_PORT advertise vendor-specific avaya-extreme file-
server $fileserver
  configure lldp port $EVENT.USER_PORT advertise vendor-specific avaya-extreme dot1q-
framing tag
  if (!$match($setQuality,true)) then
    configure port $EVENT.USER_PORT qosprofile qp7
  endif
endif

```

```

endif
#
if (!$match($EVENT.NAME,USER-UNAUTHENTICATED)) then
  create log message Starting_Avaya_VOIP_802.1x_UNATUH_Module_Config
    if (!$match($sendTraps,true)) then
      enable snmp traps lldp ports $EVENT.USER_PORT
      enable snmp traps lldp-med ports $EVENT.USER_PORT
    else
      disable snmp traps lldp ports $EVENT.USER_PORT
      disable snmp traps lldp-med ports $EVENT.USER_PORT
    endif
  disable lldp port $EVENT.USER_PORT
  if (!$match($setQuality,true)) then
    unconfig qosprofile ports $EVENT.USER_PORT
  endif
endif
endif

create log message End_Avaya_VOIP_802.1x_Module_Config

```

Sample Static Profiles

The following configuration creates a profile and runs it statically:

```

* BD-10808.4 # Create upm profile p1
Enable port 1:1
.

* BD-10808.4 #run upm profile p1

* BD-10808.4 # show upm history exec 8006

UPM Profile: p1
Event: User Request      , Time run: 2006-10-18 11:56:15
Execution Identifier: 8006      Execution Status: Pass
Execution Information:
1 # enable cli scripting
2 # set var EVENT.NAME USER-REQUEST
3 # set var EVENT.TIME 1161172575
4 # set var EVENT.PROFILE p1
5 # enable port 1:1

```

This profile creates and configures EAPS on the edge switch for connecting to the aggregation switch, creates specific VLANs and assigns tags, configures network login, and configures the RADIUS client component on the switch.

```

*****
# Last Updated: May 11, 2007
# Tested Devices: X450e EXOS 12.0
# Description: This profile configures the switch with an EAPs ring, creates specified
# vlans, configure network login, RADIUS.
*****
# @MetaDataStart
# @ScriptDescription "This is a template for configuring network parameters for edge
Summit devices. The profile will configure the listed features: EAPs ring, Network
login, 802.1x, vlans, and default routes."
# @VariableFieldLabel "Create EAPs ring? (yes or no)"

```

```

set var yneaps yes
# @VariableFieldLabel "Name of EAPs domain"
set var eapsdomain upm-domain
# @VariableFieldLabel "Primary port number"
set var eapsprimary 23
# @VariableFieldLabel "Secondary port number"
set var eapssecondary 24
# @VariableFieldLabel "Name of EAPs control VLAN"
set var eapsctrl upm_ctrl
# @VariableFieldLabel "Tag for EAPs control VLAN"
set var eapsctrltag 4000
# @VariableFieldLabel "Create standard VLANs? (yes or no)"
set var ynvlan yes
# @VariableFieldLabel "Name of Voice vlan"
set var vvoice voice
# @VariableFieldLabel "Voice VLAN tag"
set var vvoicetag 10
# @VariableFieldLabel "Voice VLAN virtual router"
set var vvoicevr vr-default
# @VariableFieldLabel "Name of Security Video"
set var vidsec vidcam
# @VariableFieldLabel "Security Video VLAN tag"
set var vidsectag 40
# @VariableFieldLabel "Security Video VLAN virtual router"
set var vidsecvr vr-default
# @VariableFieldLabel "Name of Data vlan"
set var vdata datatraffic
# @VariableFieldLabel "Data VLAN tag"
set var vdatatag 11
# @VariableFieldLabel "Data VLAN virtual router"
set var vdatavr vr-default
# @VariableFieldLabel "Enable Network Login? (yes or no)"
set var ynetlogin yes
# @VariableFieldLabel "RADIUS Server IP Address"
set var radserver 192.168.11.144
# @VariableFieldLabel "RADIUS Client IP Address"
set var radclient 192.168.11.221
# @VariableFieldLabel "RADIUS Server Shared Secret"
set var radsecret goextreme
# @VariableFieldLabel "Network Login port list"
set var netloginports 1-20
# @MetaDataEnd
#####
# Start of EAPs Configuration block
#####
if (!$match($yneaps,yes)) then
    create log message Config_EAPs
    config eaps config-warnings off
    create eaps $eapsdomain
    config eaps $eapsdomain mode transit
    config eaps $eapsdomain primary port $eapsprimary
    config eaps $eapsdomain secondary port $eapssecondary
    create vlan $eapsctrl
    config $eapsctrl tag $eapsctrltag
    config $eapsctrl qosprofile qp8
    config $eapsctrl add port $eapsprimary tagged

```

```

    config $eapsctrl add port $eapssecondary tagged
    config eaps $eapsdomain add control vlan $eapsctrl
    enable eaps
    enable eaps $eapsdomain
endif
    create log message EAPs_Not_Configured
endif
#####
#VLAN Config
#####
if (!$match($ynvlan,yes)) then
    create log message CreateStandardVLANs
    create vlan $vvoice vr $vvoicevr
    config vlan $vvoice tag $vvoicetag
    config vlan $vvoice add port $eapsprimary tagged
    config vlan $vvoice add port $eapssecondary tagged
    config eaps $eapsdomain add protected $vvoice
    enable lldp ports $netloginports
    create qosprofile qp5
    config vlan $vvoice ipa 192.168.10.221
#
    create vlan $vidsec vr $vidsecvr
    config vlan $vidsec tag $vidsectag
    config vlan $vidsec add port $eapsprimary tagged
    config vlan $vidsec add port $eapssecondary tagged
    config eaps $eapsdomain add protected $vidsec
    config vlan $vidsec ipa 192.168.40.221
#
    create vlan $vdata vr $vdatavr
    config vlan $vdata tag $vdatatag
    config vlan $vdata add port $eapsprimary tagged
    config vlan $vdata add port $eapssecondary tagged
    config eaps $eapsdomain add protected $vdata
    config vlan $vdata ipa 192.168.11.221
# config ipr add default 192.168.11.254 vr vr-default
else
    create log message NoVLANsCreated
endif
#####
#RADIUS & Netlogin
#####
if (!$match($ynnetlogin,yes)) then
    create log message ConfigNetlogin
#configure $vdata ipaddress 192.168.11.221
    create vlan nvlan
    config netlogin vlan nvlan
    config default del po $netloginports
    enable netlogin dot1x
    enable netlogin mac
    enable netlogin ports $netloginports dot1x mac
    config netlogin ports $netloginports mode mac-based-vlans
    config radius netlogin primary server $radserver client-ip $radclient vr VR-Default
    config radius netlogin primary shared-secret $radsecret
    enable radius netlogin
    config netlogin add mac-list 00:19:5B:D3:e8:DD

```

```

else
  create log message NoNetlogin
endif

```

Sample Configuration with Device-Triggered Profiles

The following example demonstrates how to configure Universal Port for device detection:

```

# Create and configure the VLAN for the VoIP network.
#
X450e-24p.1 # create vlan voice
X450e-24p.2 # configure voice ipaddress 192.168.0.1/24

# Create the universal port profile for device-detect on the switch.
#
X450e-24p.3 # create upm profile detect-voip
Start typing the profile and end with a . as the first and the only character on a
line.
Use - edit upm profile <name> - for block mode capability

create log message Starting_Script_DETECT-voip
set var callServer 192.168.10.204
set var fileServer 192.168.10.194
set var voiceVlan voice
set var CleanupProfile CleanPort
set var sendTraps false
#
create log message Starting_DETECT-VOIP_Port_${EVENT}.USER_PORT

#*****
# adds the detected port to the device "unauthenticated" profile port list
#*****
create log message Updating_UnDetect_Port_List_Port_${EVENT}.USER_PORT
configure upm event Device-UnDetect profile CleanupProfile ports ${EVENT}.USER_PORT

#*****
# adds the detected port to the proper VoIP vlan
#*****
configure $voiceVlan add port ${EVENT}.USER_PORT tag

#*****
# Configure the LLDP options that the phone needs
#*****
configure lldp port ${EVENT}.USER_PORT advertise vendor-specific avaya-extreme call-
server $callServer
configure lldp port ${EVENT}.USER_PORT advertise vendor-specific avaya-extreme file-
server $fileServer
configure lldp port ${EVENT}.USER_PORT advertise vendor-specific avaya-extreme dot1q-
framing tagged
configure lldp port ${EVENT}.USER_PORT advertise vendor-specific med capabilities

#configure lldp port ${EVENT}.USER_PORT advertise vendor-specific med policy application
voice vlan $voiceVlan dscp 46

```

```

#*****
# Configure the POE limits for the port based on the phone requirement
#*****
# If port is PoE capable, uncomment the following lines

#configure lldp port $EVENT.USER_PORT advertise vendor-specific med power-via-mdi
#configure inline-power operator-limit $EVENT.DEVICE_POWER ports $EVENT.USER_PORT

create log message Script_DETECT-phone_Finished_Port_$EVENT.USER_PORT
.
X450e-24p.4 #

# Create the universal port profile for device-undetected on the switch.
#
* X450e-24p.5 # create upm profile clearports
Start typing the profile and end with a . as the first and the only character on a
line.
Use - edit upm profile <name> - for block mode capability

create log message STARTING_UPM_Script_CLEARPORT_on_$EVENT.USER_PORT
#configure $voiceVlan delete port $EVENT.USER_PORT

unconfigure lldp port $EVENT.USER_PORT
create log message LLDP_Info_Cleared_on_$EVENT.USER_PORT

#unconfigure upm event device-undetected profile avaya-remove ports $EVENT.USER_PORT

unconfigure inline-power operator-limit ports $EVENT.USER_PORT
create log message POE_Settings_Cleared_on_$EVENT.USER_PORT

create log message FINISHED_UPM_Script_CLEARPORT_on_$EVENT.USER_PORT
.
* X450e-24p.5 #
#
# Assign the device-detect profile to the edge ports.
#
* X450e-24p.6 # config upm event device-detect profile detect-voip ports 1-10
#
# Assign the device-undetected profile to the edge ports.
#
* X450e-24p.7 # config upm event device-undetected profile clearports ports 1-10
* X450e-24p.8 #
#
# Verify that correct profiles are assigned to correct ports.
#
* X450e-24p.9 # show upm profile
UPM Profile          Events          Flags Ports
=====
clearports           Device-Undetect    e 1-10
detect-voip          Device-Detect      e 1-10
=====
Number of UPM Profiles: 2
Number of UPM Events in Queue for execution: 0
Flags: d - disabled, e - enabled
Event name: log-message(Log filter name) - Truncated to 20 chars

```

```
#
# Enable LLDP message advertisements on the ports assigned to universal ports.
#
* X450e-24p.10 # enable lldp ports 1-10
```

Sample Configuration with User-Triggered Profiles

The example in this section demonstrates how to configure a RADIUS server and Universal Port for user login. The first part of the example shows the RADIUS server configuration. For more information on RADIUS server configuration, see [Chapter 23, "Security."](#)

```
# Configure the RADIUS server for the userID and password pair.
# For FreeRADIUS, edit the users file located at /etc/raddb/users as shown in the
# following lines.
#
#Sample entry of using an individual MAC addresses
00040D50CCC3    Auth-Type := EAP, User-Password == "00040D50CCC3"
Extreme-Security-Profile = "phone LOGOFF-PROFILE=clearport;",
    Extreme-Netlogin-VLAN = voice

#Sample entry of using wildcard MAC addresses (OUI Method)

00040D000000    Auth-Type := EAP, User-Password == "1234"
Extreme-Security-Profile = "phone LOGOFF-PROFILE=clearport;",
    Extreme-Netlogin-VLAN = voice

#Sample entry of using numeric UserID and password

10284    Auth-Type := EAP, User-Password == "1234"
Extreme-Security-Profile = "voip LOGOFF-PROFILE=voip",
    Extreme-Netlogin-Vlan = voice

#Sample entry of using a text UserID and password

Sales    Auth-Type := EAP, User-Password == "Money"
Extreme-Security-Profile = "Sales-qos LOGOFF-PROFILE=Sales-qos",
    Extreme-Netlogin-Vlan = v-sales

# Define the Extreme custom VSAs on RADIUS.
# For FreeRADIUS, edit the dictionary file located at //etc/raddb/dictionary to
# include the following details:
VENDOR      Extreme      1916
ATTRIBUTE   Extreme-CLI-Authorization    201    integer Extreme
ATTRIBUTE   Extreme-Shell-Command         202    string  Extreme
ATTRIBUTE   Extreme-Netlogin-Vlan         203    string  Extreme
ATTRIBUTE   Extreme-Netlogin-Url         204    string  Extreme
ATTRIBUTE   Extreme-Netlogin-Url-Desc    205    string  Extreme
ATTRIBUTE   Extreme-Netlogin-Only        206    integer Extreme
ATTRIBUTE   Extreme-User-Location        208    string  Extreme
ATTRIBUTE   Extreme-Netlogin-Vlan-Tag    209    integer Extreme
ATTRIBUTE   Extreme-Netlogin-Extended-Vlan 211    string  Extreme
ATTRIBUTE   Extreme-Security-Profile     212    string  Extreme
```

```

VALUE Extreme-CLI-Authorization Disabled 0
VALUE Extreme-CLI-Authorization Enabled 1
VALUE Extreme-Netlogin-Only Disabled 0
VALUE Extreme-Netlogin-Only Enabled 1
# End of Dictionary

# Add the switch as an authorized client of the RADIUS server.
# For FreeRADIUS, edit the file located at //etc/raddb/clients.conf to include the
# switches as details:
#
client 192.168.10.4 {
    secret = purple
    shortname = x450e-24p
# End of clients.conf

```

The rest of this example demonstrates the configuration that takes place at the ExtremeXOS switch:

```

# Create the universal port profile for user-authenticate:

* X450e-24p.1 # create upm profile phone
Start typing the profile and end with a . as the first and the only character on a
line.
Use - edit upm profile <name> - for block mode capability

create log message Starting_Script_Phone
set var callServer 192.168.10.204
set var fileServer 192.168.10.194
set var voiceVlan voice
set var CleanupProfile CleanPort
set var sendTraps false

#
create log message Starting_AUTH-VOIP_Port_${EVENT}.USER_PORT

#*****
# adds the detected port to the device "unauthenticated" profile port list
#*****

create log message Updating_Unauthenticated_Port_List_Port_${EVENT}.USER_PORT

#*****
# Configure the LLDP options that the phone needs
#*****

configure lldp port ${EVENT}.USER_PORT advertise vendor-specific avaya-extreme call-
server $callServer
configure lldp port ${EVENT}.USER_PORT advertise vendor-specific avaya-extreme file-
server $fileServer
configure lldp port ${EVENT}.USER_PORT advertise vendor-specific avaya-extreme dot1q-
framing tagged
configure lldp port ${EVENT}.USER_PORT advertise vendor-specific med capabilities

# If port is PoE capable, uncomment the following lines

#create log message UPM_Script_A-Phone_Finished_Port_${EVENT}.USER_PORT
.

```

```
X450e-24p.2 #

#
# Create the universal port profile for user-unauthenticate on the switch:
#
* X450e-24p.1 # create upm profile clearport
Start typing the profile and end with a . as the first and the only character on a
line.
Use - edit upm profile <name> - for block mode capability

create log message STARTING_Script_CLEARPORT_on_${EVENT}.USER_PORT

unconfigure lldp port ${EVENT}.USER_PORT
create log message LLDP_Info_Cleared_on_${EVENT}.USER_PORT

unconfigure inline-power operator-limit ports ${EVENT}.USER_PORT
create log message POE_Settings_Cleared_on_${EVENT}.USER_PORT

create log message FINISHED_Script_CLEARPORT_on_${EVENT}.USER_PORT
.
* X450e-24p.2 #

# Configure RADIUS on the edge switch.
#
* X450e-24p.4 # config radius primary server 192.168.11.144 client-ip 192.168.10.4 vr
"VR-Default"
* X450e-24p.5 # config radius primary shared-secret purple

# Configure Network Login on the edge switch.
#
For Network Login 802.1x, use the following commands:
* X450e-24p.7 # create vlan nvlan
* X450e-24p.8 # config netlogin vlan nvlan
* X450e-24p.9 # enable netlogin dot1x
* X450e-24p.10 # enable netlogin ports 11-20 mode mac-based-vlans
* X450e-24p.11 # enable radius netlogin
#
# For Network Login MAC-based or OUI method, use the following commands:
* X450e-24p.7 # create vlan nvlan
* X450e-24p.8 # config netlogin vlan nvlan
* X450e-24p.9 # enable netlogin mac
* X450e-24p.10 # config netlogin add mac-list 00:04:0D:00:00:00 24 1234
* X450e-24p.11 # enable radius netlogin

# Assign the user-authenticate profile to the edge port.
#
* X450e-24p.12 # configure upm event user-authenticate profile "phone" ports 11-20
* X450e-24p.13 #

# Assign the user-unauthenticate profile to the edge port.
#
* X450e-24p.14 # configure upm event user-unauthenticated profile "clearport" ports
11-20
* X450e-24p.15 #
```

```
# Check that the correct profiles are assigned to the correct ports.
#
* X450e-24p.16 # show upm profile
=====
UPM Profile          Events                Flags Ports
=====
phone                User-Authenticated    e  11-20
clearport            User-Unauthenticated  e  11-20
=====
Number of UPM Profiles: 5
Number of UPM Events in Queue for execution: 0
Flags: d - disabled, e - enabled
Event name: log-message(Log filter name) - Truncated to 20 chars

# Enable LLDP message advertisements on the ports.
#
* X450e-24p.17 # enable lldp ports 11-20
```

Sample Timer-Triggered Profile

The following profile and timer configuration disables PoE on ports 1 to 20 everyday at 6 p.m.:

```
* X450e-24p.1 # create upm profile eveningpoe
Start typing the profile and end with a . as the first and the only character on a
line.
Use - edit upm profile <name> - for block mode capability

create log message Starting_Evening
disable inline-power ports 1-20

.
*X450e-24p.2
*X450e-24p.3 # create upm timer night
*X450e-24p.4 # config upm timer night profile eveningpoe
*X450e-24p.5 # config upm timer night at 7 7 2007 19 00 00 every 86400
```

Sample Profile with QoS Support

The example below can be used with a Summit family switch that supports QoS profiles qp1 and qp8. When the user or phone logs in with a particular MAC address, the script configures the QoS profile configured by the user in the RADIUS server for the *USER-AUTHENTICATED* event. In this example, the user sets the QoS profile to be qp8.

You must configure network login, the RADIUS server, and Universal Port on the switch as part of the user log-in authentication process. The following example is an entry in the RADIUS *users* file for the MAC address of the phone:

```
00040D9D12A9 Auth-Type := local, User-Password == "test"
      Extreme-security-profile = "p1 QOS=\"QP8\";LOGOFF-PROFILE=p2;VLAN=\"voice-
      test\";"
```

For more information on configuring the RADIUS *users* file, see [Chapter 23, “Security.”](#)

Below is the Universal Port profile configuration for this example:

```
Create upm profile p1
```

```

set var z1 $uppercase($EVENT.USER_MAC)
set var z2 $uppercase(00:04:0d:9d:12:a9)

#show var z1
#show var z2
if ($match($EVENT.NAME, USER-AUTHENTICATED) == 0) then
  if ($match($z1, $z2) == 0) then
    configure port $EVENT.USER_PORT qosprofile $QOS
  endif
endif
.

```

Sample Event Profile

If not configured properly, the Spanning Tree Protocol (STP) can create loops in a network. Should these loops develop, they can cause network degradation and eventually crash the network by duplicating too many Ethernet frames. By leveraging Universal Port and the Extreme Loop Recovery Protocol (ELRP) as shown in example below, it is not only possible to detect and isolate the egress port, but it is also possible to disable the egress port to break loops.



NOTE

This example illustrates how to create an event profile that reconfigures the switch after an event. After this example was created, ELRP was updated with the capability to disable a port without the help of an event profile. For more information, see [“Using ELRP to Perform Loop Tests” on page 1530](#).

When a loop is detected on ports where ELRP is enabled and configured, ELRP logs a message using the following format:

```
01/17/2008 08:08:04.46 <Warn:ELRP.Report.Message> [CLI:ksu:1] LOOP DETECTED : 436309
transmitted, 64 received, ingress slot:port (1) egress slot:port (24)
```

To view more information on format of this command, enter the `show log events` command as shown in the following example:

```
* BD8810-Rack2.6 # show log events "ELRP.Report.Message" details
Comp      SubComp    Condition          Severity          Parameters
-----
ELRP      Report     Message            Warning           8 total
                                                0 - string
                                                1 - string
                                                2 - number (32-bit
unsigned int)
                                                3 - string
                                                4 - number (32-bit
unsigned int)
                                                5 - number (unsigned int)
                                                6 - string
                                                7 - string
                "[%%%1%:%2%] %3% : %4% transmitted, %5% received, ingress
slot:port (%6%) egress slot:port (%7%)"
```

In the example log statement, the VLAN *ksu*, the ports is *all*, and the interval is “1.”

If a loop is detected, we want to disable the egress port on which the ELRP control packets went out. In this example, we enable ELRP on all ports of a VLAN as follows:

```
configure elrp-client periodic <vlan> ports <all> interval 1
```

We want the profile to disable egress ports 1 and 24 (which have been configured for loop). If we enable ELRP on only one port, then the port alone would be disabled.

We observe that parameter 7 is the one we have to disable from the above log message and the details for that event.

The following procedure configures Universal Port to disable the egress port identified by parameter 7:

1 Create the profile and add the command to disable the egress port as follows:

```
create upm profile disable_port_elrp
disable port $EVENT.LOG_PARAM_7
.
```

2 Verify that the profile is created and enabled by entering the following command:

```
show upm profile
```

3 Create the EMS configuration by entering the following commands:

```
create log target upm disable_port_elrp
create log filter f1
configure log filter f1 add event ELRP.Report.Message match string "LOOP"
enable log target upm "disable_port_elrp"
configure log target upm "disable_port_elrp" filter f1
```

At this point, connect the ports 1 and 24 to form a loop. Two log messages will be logged when the loop is detected on ports 1 and 24 and ELRP is enabled both. This triggers the `disable_port_elrp` profile twice, and ports 1 and 24 should be disabled. You can view this by entering the `show log` command as in the following example:

```
> show log
01/17/2008 08:08:05.49 <Info:vlan.dbg.info> Port 24 link down
01/17/2008 08:08:05.22 <Noti:UPM.Msg.upmMsgExshLaunch> Launched profile
disable_port_elrp for the event log-message
01/17/2008 08:08:04.69 <Info:vlan.dbg.info> Port 1 link down
01/17/2008 08:08:04.46 <Noti:UPM.Msg.upmMsgExshLaunch> Launched profile
disable_port_elrp for the event log-message
01/17/2008 08:08:04.46 <Warn:ELRP.Report.Message> [CLI:ksu:1] LOOP DETECTED : 436309
transmitted, 64 received, ingress slot:port (1) egress slot:port (24)
01/17/2008 08:08:04.46 <Warn:ELRP.Report.Message> [CLI:ksu:1] LOOP DETECTED : 436309
transmitted, 63 received, ingress slot:port (24) egress slot:port (1)
01/17/2008 08:08:03.50 <Info:vlan.dbg.info> Port 24 link up at 1 Gbps speed and full-
duplex
```

To view the profile execution history, enter the `show upm history` command. If you want to see the more details, enter the `show upm history details` command to see all the profiles or display information on a specific event by entering the `exec-id`.

To view the configuration, use the `show config upm` and `show config ems` commands.

Sample Configuration for Generic VoIP LLDP

```

*****
# Last Updated: March 20, 2007
# Tested Phones: Avaya 4610, 4620, 4625
# Requirements: LLDP capable devices
*****
# @META_DATA_START
# @FileDescription "This is a template for configuring network parameters for VoIP
phones support LLDP but without 802.1x authentication. The module is triggered
through the detection of an LLDP packet on the port. The following network side
configuration is done: enable SNMP traps, QoS assignment, adjust POE reservation
values based on device requirements, add the voiceVlan to the port as tagged."
# @Description "Voice VLAN name"
set var voicevlan voice
# @Description "Send trap when LLDP event happens (true or false)"
set var sendTraps false
# @Description "Set QoS Profile (true or false)"
set var setQuality false
# @META_DATA_END
#
if (!$match($EVENT.NAME,DEVICE-DETECT)) then
    create log message Starting_LLDP_Generic_Module_Config
# VoiceVLAN configuration
configure vlan $voicevlan add port $EVENT.USER_PORT tagged
#SNMP Trap
    if (!$match($sendTraps,true)) then
        create log message Config_SNMP_Traps
        enable snmp traps lldp ports $EVENT.USER_PORT
        enable snmp traps lldp-med ports $EVENT.USER_PORT
    else
        disable snmp traps lldp ports $EVENT.USER_PORT
        disable snmp traps lldp-med ports $EVENT.USER_PORT
    endif
#Link Layer Discovery Protocol-Media Endpoint Discover
create log message Config_LLDP
configure lldp port $EVENT.USER_PORT advertise vendor-specific med capabilities
configure lldp port $EVENT.USER_PORT advertise vendor-specific dot1 vlan-name vlan
$voicevlan
configure lldp port $EVENT.USER_PORT advertise vendor-specific med policy application
voice vlan $voicevlan dscp 46
configure lldp port $EVENT.USER_PORT advertise vendor-specific med power-via-mdi
#Configure POE settings per device requirements
create log message Config_POE
configure inline-power operator-limit $EVENT.DEVICE_POWER ports $EVENT.USER_PORT
#QoS Profile
    if (!$match($setQuality,true)) then
        create log message Config_QoS
        configure port $EVENT.USER_PORT qosprofile qp7
    endif
endif

```

```

if (!$match($EVENT.NAME,DEVICE-UNDETECT) && $match($EVENT.DEVICE_IP,0.0.0.0)) then
  create log message Starting_LLDP_Generic_UNATUH_Module_Config
  if (!$match($sendTraps,true)) then
    create log message UNConfig_SNMP_Traps
    disable snmp traps lldp ports $EVENT.USER_PORT
    disable snmp traps lldp-med ports $EVENT.USER_PORT
  endif
  create log message UNConfig_LLDP
  unconfig lldp port $EVENT.USER_PORT
  if (!$match($setQuality,true)) then
    create log message UNConfig_QOS
    unconfig qosprofile ports $EVENT.USER_PORT
  endif
  unconfig inline-power operator-limit ports $EVENT.USER_PORT
endif
if (!$match($EVENT.NAME,DEVICE-UNDETECT) && !$match($EVENT.DEVICE_IP,0.0.0.0)) then
  create log message DoNothing_0.0.0.0
  create log message $EVENT.TIME
endif
create log message End_LLDP_Generic_Module_Config

```

Sample Configuration for Generic VoIP 802.1x

```

#*****
# Last Updated: April 6, 2007
# Tested Phones: Avaya 4610, 4620, 4625
# Requirements: 802.1x capable devices, netlogin configured and enabled on deployment
ports
#*****
# @META_DATA_START
# @FileDescription "This is a template for configuring network parameters for 802.1x
authenticated devices. The module is triggered through successful authentication of
the device. The following network side configuration is done: QoS assignment and
enables DOS protection. When used with IP phones, phone provisioning is done through
DHCP options."
# @Description "VLAN name to add to port"
set var vlan1 voice
# @Description "Set QoS Profile (yes or no)"
set var setQuality yes
# @Description "QoS Profile (0-100)"
set var lowbw 50
# @Description "QoS MAX Bandwidth (0-100)"
set var highbw 100
# @Description "Enable Denial of Service Protection (yes or no)"
set var dosprotection yes
# @META_DATA_END

```

```
#####
# Start of USER-AUTHENTICATE block
#####
if (!$match($EVENT.NAME,USER-AUTHENTICATED)) then
#####
#QoS Profile
#####
# Adds a QoS profile to the port
  if (!$match($setQuality,yes)) then
    create log message Config_QoS
    configure port $EVENT.USER_PORT qosprofile qp7
    configure qosprofile qp7 minbw $lowbw maxbw $highbw ports $EVENT.USER_PORT
  endif
#
#####
#Security Configurations
#####
create log message Applying_Security_Limits
# enables Denial of Service Protection for the port
  if (!$match($dosprotection,yes)) then
    enable dos-protect
    create log message DOS_enabled
  endif
#
endif
#####
# End of USER-AUTHENTICATE block
```

Sample Configuration for Avaya VoIP 802.1x

```
*****
# Last Updated: March 20, 2007
# Tested Phones: SW4610, SW4620
# Requirements: 802.1x authentication server, VSA 203 and VSA 212 from authentication
server. QP7 defined on the switch#
*****
# @META_DATA_START
# @FileDescription "This is a template for configuring LLDP capable Avaya phones using
the authentication trigger. This module will provision the phone with the following
parameters: call server, file server, dot1q, dscp, power. Additionally the following
network side configuration is done: enable SNMP traps and QoS assignment."
# @Description "Avaya phone call server IP address"
set var callserver 192.45.95.100
# @Description "Avaya phone file server IP address"
set var fileserver 192.45.10.250
# @Description "Send trap when LLDP event happens (true or false)"
set var sendTraps true
# @Description "Set QoS Profile (true or false)"
set var setQuality true
# @META_DATA_END
#
```

```

if (!$match($EVENT.NAME,USER-AUTHENTICATED)) then
  create log message Starting_Avaya_VOIP_802.1x_AUTH_Module_Config
    if (!$match($sendTraps,true)) then
      enable snmp traps lldp ports $EVENT.USER_PORT
      enable snmp traps lldp-med ports $EVENT.USER_PORT
    else
      disable snmp traps lldp ports $EVENT.USER_PORT
      disable snmp traps lldp-med ports $EVENT.USER_PORT
    endif
  enable lldp port $EVENT.USER_PORT
  configure lldp port $EVENT.USER_PORT advertise vendor-specific dot1 vlan-name
  configure lldp port $EVENT.USER_PORT advertise vendor-specific avaya-extreme call-
server $callserver
  configure lldp port $EVENT.USER_PORT advertise vendor-specific avaya-extreme file-
server $filesaver
  configure lldp port $EVENT.USER_PORT advertise vendor-specific avaya-extreme dot1q-
framing tag
  if (!$match($setQuality,true)) then
    configure port $EVENT.USER_PORT qosprofile qp7
  endif
endif
#
if (!$match($EVENT.NAME,USER-UNAUTHENTICATED)) then
  create log message Starting_Avaya_VOIP_802.1x_UNATUH_Module_Config
    if (!$match($sendTraps,true)) then
      enable snmp traps lldp ports $EVENT.USER_PORT
      enable snmp traps lldp-med ports $EVENT.USER_PORT
    else
      disable snmp traps lldp ports $EVENT.USER_PORT
      disable snmp traps lldp-med ports $EVENT.USER_PORT
    endif
  disable lldp port $EVENT.USER_PORT
  if (!$match($setQuality,true)) then
    unconfig qosprofile ports $EVENT.USER_PORT
  endif
endif

create log message End_Avaya_VOIP_802.1x_Module_Config

Dynamic Security Policy
if (!$match($CLI_EVENT,USER-AUTHENTICATED) ) then
  create access-list $(DEVICE_MAC)_192_168_1_0 "ethernet-source-address $DEVICE_MAC ;
destination-address 192.168.1.0/24 " "permit "
  create access-list $(DEVICE_MAC)_192_168_2_0 "ethernet-source-address $DEVICE_MAC ;
destination-address 192.168.2.0/24 " "permit "
  create access-list $(DEVICE_MAC)_192_168_3_0 "ethernet-source-address $DEVICE_MAC ;
destination-address 192.168.3.0/24 " "permit "
  create access-list $(DEVICE_MAC)_smtp "ethernet-source-address $DEVICE_MAC ;
destination-address 192.168.100.125/32 ; protocol tcp ; destination-port 25" "permit "
  create access-list $(DEVICE_MAC)_http "ethernet-source-address $DEVICE_MAC ;
protocol tcp ; destination-port 80" "permit "
  create access-list $(DEVICE_MAC)_https "ethernet-source-address $DEVICE_MAC ;
protocol tcp ; destination-port 443" "permit "

```

```

create access-list $(DEVICE_MAC)_dhcp "protocol udp; destination-port 67" "permit"
create access-list $(DEVICE_MAC)_deny "destination-address 0.0.0.0/0" "deny "
configure access-list add $(DEVICE_MAC)_192_168_1_0 first port $USER_PORT
configure access-list add $(DEVICE_MAC)_192_168_2_0 first port $USER_PORT
configure access-list add $(DEVICE_MAC)_192_168_3_0 first port $USER_PORT
configure access-list add $(DEVICE_MAC)_smtp first port $USER_PORT
configure access-list add $(DEVICE_MAC)_http last port $USER_PORT
configure access-list add $(DEVICE_MAC)_https last port $USER_PORT
configure access-list add $(DEVICE_MAC)_dhcp first port $USER_PORT
configure access-list add $(DEVICE_MAC)_deny last port $USER_PORT
endif
if (!$match($CLI_EVENT,USER-UNAUTHENTICATED) ) then
# Clean up
configure access-list delete $(DEVICE_MAC)_192_168_1_0 ports $USER_PORT
configure access-list delete $(DEVICE_MAC)_192_168_2_0 ports $USER_PORT
configure access-list delete $(DEVICE_MAC)_192_168_3_0 ports $USER_PORT
configure access-list delete $(DEVICE_MAC)_smtp ports $USER_PORT
configure access-list delete $(DEVICE_MAC)_http ports $USER_PORT
configure access-list delete $(DEVICE_MAC)_https ports $USER_PORT
configure access-list delete $(DEVICE_MAC)_dhcp ports $USER_PORT
configure access-list delete $(DEVICE_MAC)_deny ports $USER_PORT
delete access-list $(DEVICE_MAC)_192_168_1_0
delete access-list $(DEVICE_MAC)_192_168_2_0
delete access-list $(DEVICE_MAC)_192_168_3_0
delete access-list $(DEVICE_MAC)_smtp
delete access-list $(DEVICE_MAC)_http
delete access-list $(DEVICE_MAC)_https
delete access-list $(DEVICE_MAC)_dhcp
delete access-list $(DEVICE_MAC)_deny
endif

```

Sample Configuration for a Video Camera

This template adds an ACL to an edge port when a video camera connects. The profile configures and applies an ACL onto a switch port when a user authenticates. This ACL blocks a particular IP address from accessing the video camera and assigns the user to QoS profile 7.

```

#####
# Last Updated: March 9, 2007
# Tested Devices: Dlink DCS 1110
# Requirements: netlogin configured and enabled on deployment ports
#####
#@MetaDataStart
#@ScriptDescription "This is a template for configuring the switch for the right
environment for this webcam. It creates a dynamic access-list to restrict access"
#@Description "VLAN name to add to port"
# set var vlan1 voiceavaya
#@VariableFieldLabel "Set QoS Profile (yes or no)"
# set var setQuality yes
#@Description "QoS Profile (0-100)"
# set var lowbw 50
#@VariableFieldLabel "QoS MAX Bandwidth (0-100)"
# set var highbw 100
#@MetaDataEnd
#####
# Start of USER-AUTHENTICATE block

```

```

#####
if (!$match($EVENT.NAME,USER-AUTHENTICATED)) then
#####
#QoS Profile
#####
# Adds a QoS profile to the port
#   if (!$match($setQuality,yes)) then
#     create log message Config_QoS
#     configure port $EVENT.USER_PORT qosprofile qp7
#     configure qosprofile qp7 minbw $lowbw maxbw $highbw ports $EVENT.USER_PORT
#   endif
#
#####
#ACL Section
#####
# Adds an ACL to stop traffic to a particular address
    create log message Config_ACL
    create access-list webcamblock "destination-address 192.168.10.220/32" "deny"
    configure access-list add webcamblock first port $EVENT.USER_PORT
#endif
#
endif
#####
# End of USER-AUTHENTICATE block
#####
#
#
#####
# Start of USER-UNAUTHENTICATE block
#####
if (!$match($EVENT.NAME,USER-UNAUTHENTICATED)) then
#   create log message Starting_8021x_Generic_UNATUH_Module_Config
#   if (!$match($setQuality,yes)) then
#     create log message UNConfig_QoS
#     unconfig qosprofile ports $EVENT.USER_PORT
#   endif
#   unconfigure inline-power operator-limit ports $EVENT.USER_PORT
#### remove acl
    configure access-list delete webcamblock port $EVENT.USER_PORT
    delete access-list webcamblock
endif
#####
# End of USER-UNAUTHENTICATE block
#####
create log message End_802_1x_Generic_Module_Config

```

7 Using CLI Scripting

CHAPTER

This chapter includes the following sections:

- [Overview on page 377](#)
- [Setting Up Scripts on page 377](#)
- [Displaying CLI Scripting Information on page 386](#)
- [CLI Scripting Examples on page 387](#)

Overview

CLI-based scripting allows you to create a list of commands that you can execute manually with a single command or automatically when a special event occurs. CLI-based scripting supports variables and functions, so that you can write scripts that operate unmodified on multiple switches and in different environments. CLI-based scripting allows you to significantly automate switch management.



NOTE

Special scripts can be used to configure the switch when it boots. For more information, see [“Using Autoconfigure and Autoexecute Files” on page 1497](#).

Setting Up Scripts

The following sections describe the tasks for creating, configuring, and executing scripts:

- [Enabling and Disabling CLI Scripting on page 378](#)
- [Creating Scripts on page 378](#)
- [Using Script Variables on page 379](#)
- [Using Special Characters in Scripts on page 381](#)
- [Using Operators on page 381](#)
- [Using Control Structures in Scripts on page 382](#)
- [Using Built-In Functions on page 383](#)
- [Controlling Script Configuration Persistence on page 384](#)

- [Saving, Retrieving, and Deleting Session Variables on page 384](#)
- [Nesting Scripts on page 384](#)
- [Executing Scripts on page 385](#)
- [Configuring Error Handling on page 385](#)

Enabling and Disabling CLI Scripting

CLI scripting is disabled by default. To support scripting, including the testing of script-related commands, you must enable scripting using the following command:

```
enable cli scripting {permanent}
```

The `permanent` option enables CLI scripting for new sessions only and makes the configuration change part of the permanent switch configuration so that the scripting configuration remains the same when the switch reboots. When the command is used without the `permanent` option, it enables CLI scripting for the current session only. If you do not include the `permanent` option, CLI scripting is disabled the next time the switch boots.



NOTE

CLI scripting cannot be enabled when CLI space auto completion is enabled with the `enable cli space-completion` command.

To disable scripting, enter the following command:

```
disable cli scripting {permanent}
```

Creating Scripts

There are two ways to create scripts. The method you choose depends on how you want to execute the script. If you want to create a script file to configure a switch or a switch feature, and you plan to execute that script manually, you can create a script file. If you want to create a script that is activated automatically when a device or user connects to or disconnects from a switch port, you should create the script with the Universal Port feature. The following sections provide more information on these options.

Creating a Script File

A script file is an ASCII text file that you can create with any ASCII text editor program. The text file can contain CLI commands and can use the scripting options described in the following sections:

- [Using Script Variables on page 379](#)
- [Using Special Characters in Scripts on page 381](#)
- [Using Operators on page 381](#)
- [Using Control Structures in Scripts on page 382](#)
- [Using Built-In Functions on page 383](#)

You can move an ASCII script file to the switch using the same techniques described for managing ASCII configuration files in Appendix B, Software Upgrade and Boot Options.

Creating Scripts for Use with the Universal Port Feature

The Universal Port feature allows you to create dynamic profiles that are activated by a trigger event, such as a user or device connection to a switch port. These dynamic profiles contain script commands and cause dynamic changes to the switch configuration to enforce a policy. The universal port profiles support all the scripting options listed above for creating script files. For more information on entering script commands in a universal port profile, see [Chapter 6, “Universal Port.”](#)

Using Script Variables

Variable names must be followed by white space or otherwise enclosed in parentheses. For example: `create vlan v($X)e` where X is the variable. The variable created will persist through the session and will not get reset after disable/enable cli scripting.

[Table 37](#) shows the predefined system variables that are always available for use by any script. Predefined variables are automatically set up for use before a script or profile is executed.



NOTE

You must enable CLI scripting before using these variables or executing a script.

Table 37: Predefined System Variables

Variable Syntax	Definition
\$STATUS	Status of last command execution. Values -100 to 100 are reserved and automatically set by the software, but you can override the value with the command <code>return <statusCode></code> . Common values are: <ul style="list-style-type: none"> • 0—Successful command completion • -53—Variable not found • -57—WHILE depth exceeded • -78—Script timeout
\$CLI.USER	UserName who is executing this CLI.
\$CLI.SESSION_TYPE	Type of session of the user.
\$CLI.SCRIPT_TIME_REMAINING	When a script timeout value is configured with the <code>configure cli script timeout <timeout></code> command, the system creates this variable, which returns the following values (in seconds): <ul style="list-style-type: none"> • If no script is running, this variable returns the configured timeout value. • If a script is aborted due to timeout, this variable returns the value 0. • If a script finishes execution (before the timeout value is reached) this variable returns the remaining time.
\$CLI.SCRIPT_TIMEOUT	When a script timeout value is configured with the <code>configure cli script timeout <timeout></code> command, the system creates this variable, which returns the current timeout value. If no script is running, this variable returns the configured timeout value.

[Table 38](#) shows the system variables that you must define before use.

Table 38: System Variables that Must be Created

Variable Syntax	Definition
\$CLI.OUT	<p>Output of last <code>show</code> command. The maximum size of this variable is 1 MB. This output can be used for operations such as <code>match</code> and <code>regexp</code>. For more information on these operations, see “Using Built-In Functions” on page 383.</p> <p>You must define this variable before it is used. To define this variable, enter either of the following statements:</p> <pre>set var CLI.OUT " "</pre> <pre>set var CLI.OUT 0</pre> <p>Extreme Networks recommends that you delete this variable after each use.</p>

You can create your own variables and change the values of variables. To create a variable and set a value for it, or to change a variable value, use the following command:

```
set var <varname> <_expression>
```

When using variables, the following guidelines apply:

- Variable names are case insensitive and are limited to 32 characters.
- The variable name must be unique.
- A variable can be referenced as `$X` or `$(X)`.
- If a variable already exists, it is overwritten. No error message is displayed.
- The expression can be a constant value, another variable, or a combination of the above with operators and functions. Operators are described in [“Using Operators” on page 381](#), and functions are described in [“Using Built-In Functions” on page 383](#).
- Only the `set var CLI` command supports expression evaluation.
- If the variable name `X` contains special characters such as `+/*`, then the variable needs to be enclosed in parentheses. For example: `set var z ($(x) + 100)`.
- When you use a variable with a TCL special character in the `$TCL` function, the variable must be enclosed in braces. For example: `set var x $TCL(string length ${CLI.USER})`. For more information on TCL functions, see [“Using Built-In Functions” on page 383](#).

**NOTE**

EXOS does not consider the dot/period character as a de-limiter. This is different from standard TCL behavior, where dot/period is considered as a de-limiter.

The following examples show various ways to define or change variables:

```
set var x 100
set var x ($x + 2)
set var y ($x - 100)
```

To display all variables or a specified variables, use the following command:

```
show var {<varname>}
```

Using Special Characters in Scripts

The dollar sign (\$) character and quote (") characters have special purposes in scripts. The dollar sign character indicates a variable, and the quote characters surround text strings. To use these characters as regular characters, precede the special character with a backslash character. For example:

```
set var variablename \$<varname>
set var $CLI.USER "Robert \"Bob\" Smith"
```

Scripts also support quote characters within quotes.

Using Operators

Operators allow you to manipulate variables and evaluate strings. Some operators can be used in all numeric expressions, while others are restricted to integer or string expressions. [Table 39](#) lists the operators supported and provides comments on when they can be used. The valid operators are listed in decreasing order of precedence.

Table 39: Operators

Operator	Action	Comments
-	Unary minus	None of these operands can be applied to string operands, and the bit-wise NOT operand can be applied only to integers.
+	Unary plus	
~	Bit-wise NOT	
!	Logical NOT	None of these operands can be applied to string operands, and the remainder operand can be applied only to integers. The remainder always has the same sign as the divisor and an absolute value smaller than the divisor.
*	Multiply	
/	Divide	
%	Remainder	These operands are valid for any numeric operations.
+	Add	
-	Subtract	These operands are valid for integer operands only. A right shift always propagates the sign bit.
<<	Left shift	
>>	Right shift	
<	Boolean less	Each operator produces 1 if the condition is true, 0 otherwise. These operators can be applied to strings as well as numeric operands, in which case string comparison is used.
>	Boolean greater	
<=	Boolean less than or equal	
>=	Boolean greater than or equal	
==	Boolean equal	Each operator produces a zero or one result. These operators are valid for all operand types.
!=	Boolean not equal	
&	Bit-wise AND	This operator is valid for integer operands only.
^	Bit-wise exclusive OR	This operator is valid for integer operands only.
	Bit-wise OR	This operator is valid for integer operands only.
&&	Logical AND	This operator produces a result of 1 if both operands are non-zero. Otherwise, it produces a result of 0. This operator is valid for numeric operands only (integers or floating-point).

Table 39: Operators (Continued)

Operator	Action	Comments
	Logical OR	This operator produces a result of 0 if both operands are zero. Otherwise, it produces a result of 1.
x?y:z	If-then-else (as in the C programming language)	This operator is valid for numeric operands only (integers or floating-point). If x evaluates to non-zero, then the result is the value of y. Otherwise the result is the value of z. The x operand must have a numeric value.

Using Control Structures in Scripts

The CLI supports the control structures described in the following sections:

- [Conditional Execution on page 382](#)
- [Loop While Condition is TRUE on page 382](#)

Conditional Execution

```
IF (<expression>) THEN
```

```
<statements>
```

```
ELSE
```

```
<statements>
```

```
ENDIF
```

The expression must be enclosed in parentheses.

Loop While Condition is TRUE

```
WHILE (<expression>) DO
```

```
<statements>
```

```
ENDWHILE
```

The expression must be enclosed in parentheses.

Nesting is supported up to five levels. The Ctrl-C key combination can be used to break out of any While loop(s).

The operators mentioned in [“Using Operators” on page 381](#) can be used in an expression in the `set var` command or in an IF or WHILE condition.

If there is incorrect nesting of an IF condition or WHILE loop, an error message appears. If a user tries to type more than five WHILE loops or five IF conditions, an error message appears. Breaking out of any number of WHILE loops always clears the WHILE condition.

Comments can be inserted by using the number sign (#).

Using Built-In Functions

Built in functions allow you to manipulate and evaluate the variables inside your script and the script output. [Table 40](#) shows the built-in functions. [Table 41](#) shows the built-in Tool Command Language (TCL) functions.

Table 40: Built-In Functions

Syntax	Function
\$MATCH(string 1, string 2)	Compares the two strings string 1 and string 2. Returns 0 if string1 matches string2. It returns -1,0, or 1, depending on whether string1 is less than, equal to, or greater than string2.
\$READ(prompt)	Displays a prompt for user input and accepts input until the user presses [Return] or the session times out. Replace <code>prompt</code> with the prompt to display to the user.
\$TCL(function args)	Calls a TCL built-in function (see Table 41). Note that the software does not support the simultaneous operation of multiple TCL functions. For more information on TCL functions, go to http://www.tcl.tk/man/tcl8.3/TclCmd/contents.htm .
\$UPPERCASE(string)	Returns the string uppercased.
\$VAREXISTS(varname)	Returns zero if the specified variable does not exist. Returns non-zero if the specified variable does exist.

Table 41: Supported TCL Functions

Function	Function Type	Description
after	System related	Execute a command after a time delay.
append	String handling	Append to variable.
binary	String handling	Insert and extract fields from binary strings.
clock	System related	Obtain and manipulate time.
concat	List handling	Join lists together.
expr	Math	Evaluate an expression.
join	List handling	Create a string by joining list elements together.
lappend	List handling	Append list elements onto a variable.
lindex	List handling	Retrieve an element from a list.
linsert	List handling	Insert elements into a list.
list	List handling	Create a list.
llength	List handling	Count the number of elements in a list.
lrange	List handling	Return one or more adjacent elements from a list.
lreplace	List handling	Replace elements in a list with new elements.
lsearch	List handling	See if a list contains a particular element.
lsort	List handling	Sort the elements of a list.
regexp	String handling	Match a regular expression against a string.
regsub	String handling	Perform substitutions based on regular expression pattern matching.
re_syntax	String handling	Syntax of TCL regular expressions.
split	List handling	Split a string into a proper TCL list.
string	String handling	Manipulate strings.

For examples of scripts that use TCL functions, see [“CLI Scripting Examples” on page 387](#).

Controlling Script Configuration Persistence

When a script runs, the commands within the script can make *persistent* changes to the switch configuration, which are saved across reboots, or it can make non-persistent changes. *Non-persistent* configuration changes remain part of the switch configuration only until the switch reboots.

The default setting for scripts is *non-persistent*. To change the script configuration persistence setting, use the following command:

```
configure cli mode [persistent | non-persistent]
```

Saving, Retrieving, and Deleting Session Variables

Session variables are the set of variables that are active for a particular session. For example, if a device is detected on a universal port and this triggers a profile (and the script commands within it), the variable values that were active when the profile started are replaced with the variable values defined in the profile. The first session is the device-undetected session, and the second session is the device-detected session. Each session has its own set of variables and values.

The software allows you to save session variables before replacing them. In the example above, this allows you to retrieve the earlier values when the port returns to the device-undetected state. Up to five variables can be saved or retrieved at a time. These variables are saved to system memory using a *key*, which is an ID for the saved variables. You are responsible for generating unique keys. When you want to retrieve the variables, you use the key to identify the variables to be retrieved.

To save up to five session variables, use the command:

```
save var key <key> [<var1> <var2> ...]
```

To retrieve saved session variables, use the command:

```
load var key <key> [<var1> <var2> ...]
```

To delete saved session variables, use the command:

```
delete var key <key>
```

The variables saved by the `save var` command are saved using the specified key and are retrievable and restored in the context that this profile was applied. They are available to rollback events like user-unauthenticate and device-undetected.



NOTE

For modular switches and SummitStack, session variables are saved on the master MSM or master Summit switch. To repopulate session variables after a failover event, manually execute the appropriate script.

Nesting Scripts

The ExtremeXOS software supports three levels of nested scripts. An error appears if you attempt to start a fourth-level script. The following example demonstrates nested scripts:

```
Load script x1
```

```
# Script x1 contents:
Cmd 1
Cmd 2
Load script x2
Cmd 3
Cmd 4

# Script x2 contents:
Cmd 1
Cmd 2
Load script x3
```

In the above example, `Cmd x` is a generic representation for any script command. Script x1 is the first level script and launches the second level script Script x2. Script x2 launches the third level script Script x3. If Script x3 contained a command to launch another script, the script would not launch the software would generate an error.

Executing Scripts

You can execute scripts by loading a script file or through the Universal Port feature.

Executing a Script File

To execute a script file, transfer the script file to the switch and use the `load script <filename> {arg1} {arg2} ... {arg9}` command.

Executing a Universal Port Script

Universal port scripts are called profiles and are executed based on several types of *trigger events*, including device detection and undetection and user authentication and unauthentication. For information on how to create profiles and configure the triggers, see [Chapter 6, “Universal Port.”](#)

Configuring Error Handling

The following command controls script error handling:

```
configure cli mode scripting [abort-on-error | ignore-error]
```

The default error handling behavior is to ignore errors.

You can change options within the scripts.

Aborting a Script

There are three ways to abort a script:

- Press Ctrl-C while the script is executing
- Configure the switch to abort a script when an error occurs using the following command:
`configure cli mode scripting [abort-on-error | ignore-error]`
- Enter the following command to abort a script and store a status code in the `$$STATUS` variable:

```
return <statusCode>
```

Displaying CLI Scripting Information

You can use the information in the following sections to display CLI scripting information:

- [Viewing CLI Scripting Status on page 386](#)
- [Viewing CLI Scripting Variables on page 387](#)

Viewing CLI Scripting Status

The `show management` command displays whether or not CLI scripting is enabled, whether or not the configuration is persistent, and the CLI scripting error mode as shown in the following example:

```
show management
```

```
X450a-24t.2 # show management
```

```
CLI idle timeout           : Enabled (20 minutes)
CLI max number of login attempts : 5
CLI max number of sessions  : 16
CLI paging                 : Enabled (this session only)
CLI space-completion       : Disabled (this session only)
CLI configuration logging   : Disabled
CLI scripting              : Disabled (this session only)
CLI scripting error mode    : Ignore-Error (this session only)
CLI persistent mode        : Persistent (this session only)
CLI prompting              : Enabled (this session only)
Telnet access              : Enabled (tcp port 23 vr all)
                           : Access Profile : not set
SSH Access                 : ssh module not loaded.
Web access                  : Enabled (tcp port 80)
Total Read Only Communities : 1
Total Read Write Communities : 1
RMON                       : Disabled
SNMP access                : Enabled
                           : Access Profile Name : not set
SNMP Traps                 : Enabled
SNMP v1/v2c TrapReceivers :
  Destination      Source IP Address  Flags
  10.255.43.38 /10550      2E
  10.255.43.11 /10550      2E
  10.255.99.13 /10550      2E
  10.255.57.2  /10550      2E
  10.255.43.15 /10550      2E
  10.255.42.81 /10550      2E
```

```
Flags:  Version: 1=v1 2=v2c
        Mode: S=Standard E=Enhanced
```

```
SNMP stats:      InPkts 0      OutPkts 6      Errors 0      AuthErrors 0
                  Gets 0      GetNexts 0     Sets 0      Drops 0
```

```
SNMP traps:      Sent      6      AuthTraps Enabled
```

Viewing CLI Scripting Variables

You can use the `show var` command to display the currently defined variables and their values as shown in the following example:

```
Switch.4 # show var
-----
Count : 3
-----

-----
variableName                variableValue
-----
CLI.SESSION_TYPE            serial
CLI.USER                     admin
STATUS                       0
-----
```

Controlling CLI Script Output

When the `load script` command is entered, the software disables CLI scripting output until the script is complete, and then CLI scripting output is enabled. When the CLI scripting output is disabled, the only script output displayed is the `show var` command and its output. When the CLI scripting output is enabled, all script commands and responses are displayed.

Use the `enable cli scripting output` and `disable cli scripting output` commands to control what a script displays when you are troubleshooting.

CLI Scripting Examples

The following script creates 100 VLANs with IP Addresses from 10.1.1.1/16 to 10.100.1.1/16:

```
enable cli scripting
Set var count 1
while ($count < 101) do
Create vlan v$count
configure vlan v$count ipaddress 10.($count).1.1/16
set var count ($count + 1)
endwhile
show vlan
```

The following script introduces a 60 second delay when executed:

```
set var temp $TCL(after [expr 60 *1000])
```

The following script displays the date and time:

```
set var CLI.OUT " "  
show switch  
set var date $TCL(lrange ${CLI.OUT} 27 29)  
set var year $TCL(lrange ${CLI.OUT} 31 31)  
set var date $TCL(linsert $date 3 $year)  
set var time $TCL(lrange ${CLI.OUT} 30 30)  
show var date  
show var time
```

The following script sorts the FDB table in descending order:

```
set var CLI.OUT " "  
show fdb  
set var x1 $TCL(split ${CLI.OUT} "\n")  
set var x2 $TCL(lsort -decreasing $x1)  
set var output $TCL(join $x2 "\n")  
show var output
```

The following script extracts the MAC address given the age of an FDB entry:

```
set var CLI.OUT " "  
show fdb  
set var input $TCL(split ${CLI.OUT} "\n")  
set var y1 $TCL(lsearch -glob $input *age*)  
set var y2 $TCL(lindex $input $y1)  
set var y3 $TCL(split $y2 " ")  
set var y4 $TCL(lindex $y3 0)  
show var y4
```

8 LLDP

CHAPTER

This chapter includes the following sections:

- [Overview on page 389](#)
- [Configuring and Managing LLDP on page 395](#)
- [Displaying LLDP Information on page 404](#)

Overview

The Link Layer Discovery Protocol (LLDP) is defined by IEEE standard 802.1ab and provides a standard method for discovering physical network devices and their capabilities within a given network management domain. LLDP-enabled network devices include repeaters, bridges, access points, routers, and wireless stations, and LLDP enables these devices to do the following:

- Advertise device information and capabilities to other devices in the management domain.
- Receive and store device information received from other network devices in the management domain.

LLDP discovered information can be used to do the following:

- Discover information from all LLDP compatible devices in a multivendor environment
- Trigger universal port profiles that can configure a switch port for a remote device (See [Chapter 6, “Universal Port.”](#))
- Supply identity information that can be used for authentication and identity management (see [Chapter 22, “Identity Management.”](#))
- Provide device information to Simple Network Management Protocol (SNMP) compatible Network Management Systems such as Ridgeline, which can present the information in inventory reports and topology maps

The following sections provide additional information on LLDP support in the ExtremeXOS software:

- [Supported Advertisements \(TLVs\) on page 390](#)
- [LLDP Packets on page 393](#)
- [Transmitting LLDP Messages on page 394](#)
- [Receiving LLDP Messages on page 394](#)
- [LLDP Management on page 395](#)

Supported Advertisements (TLVs)

LLDP defines a set of common advertisement messages, which are distributed in *Type Length Value* (TLV) format in an LLDP packet (see [“LLDP Packets” on page 393](#)). The individual advertisements within the packet are called *TLVs*, and each TLV advertises device information or a device capability. Certain TLVs are mandatory and are always advertised after LLDP is enabled; optional TLVs are advertised only when so enabled by default or during configuration.

The following sections provide more information on TLVs:

- [Mandatory TLVs on page 390](#)
- [Optional TLVs on page 390](#)
- [Avaya-Extreme Networks Optional TLVs on page 391](#)
- [LLDP MED Optional TLVs on page 392](#)

Mandatory TLVs

Mandatory TLVs are those TLVs that must be advertised (as defined in IEEE standard 802.1ab) when LLDP is enabled. If you enable LLDP on a port, the mandatory TLVs are advertised and there is no command to disable this advertising.

[Table 42](#) describes the mandatory TLVs.

Table 42: Mandatory TLVs

Name	Comments
Chassis ID	<p>The ExtremeXOS software advertises the system’s MAC address in this TLV to uniquely identify the device.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">  NOTE EDP also uses the MAC address to identify the device. </div>
Port ID	<p>The ExtremeXOS software advertises the port ID in this TLV to uniquely identify the port that sends the TLVs. This port ID is the ifName object in the MIB.</p>
Time to live (TTL)	<p>This TLV indicates how long the record should be maintained in the LLDP database. The default value is 120 seconds (or 2 minutes). When a port is shutting down or LLDP is disabled on a port, this TLV is set to value 0, which indicates that the record for this port should be deleted from the database on other devices.</p> <p>Although, you cannot directly configure the TTL TLV, you can configure the transmit hold value, which is used to calculate the TTL TLV. (See “Configuring LLDP Timers” on page 397 for more information.)</p>
End-of-LLDP PDU	<p>The end-of-LLDPDU (LLDP protocol data unit) TLV marks the end of the data in each LLDP packet.</p>

Optional TLVs

IEEE standard 802.1ab defines a set of optional TLVs, which are listed in [Table 43](#). The system description TLV is advertised by default. All other optional TLVs must be configured to enable advertising. You can use the CLI to configure the optional TLVs, or you can use an SNMP-compatible network management system (NMS) such as Ridgeline. For more information on the optional TLVs, see [Configuring Optional TLV Advertisements on page 398](#).

Table 43 describes the optional TLVs.

Table 43: Optional TLVs

Name	Comments
Port description	Advertises the display-string that is configured for the port.
System name	Advertises the device's configured system name, which is configured with the <code>configure snmp sysname</code> command.
System description	Advertises <code>show version</code> command information similar to the following: <code>ExtremeXOS version 11.2.0.12 v1120b12 by release-manager on Fri Mar 18 16:01:08 PST 2005</code>
System capabilities	The default configuration advertises this optional TLV when LLDP is enabled. Advertises bridge capabilities. If IP forwarding is enabled on at least one VLAN in the switch, the software also advertises router capabilities.
Management address	Advertises the IP address of the management VLAN in the management address TLV. If the management VLAN does not have an assigned IP address, the management address TLV advertises the system's MAC address.
VLAN name	Advertises the name of a tagged VLAN for the port. You can configure this TLV multiple times to support multiple VLANs.
Port VLAN ID	Advertises the untagged VLAN on the port.
Port and protocol VLAN ID	Advertises a VLAN and whether the port supports protocol-based VLANs or not. You can configure this TLV multiple times to support multiple VLANs.
MAC/PHY configuration/status	Advertises the autonegotiation and physical layer capabilities of the port.
Power via MDI	For Ethernet (PoE) or PoE+ ports, this TLV advertises the device type, power status, power class, and pin pairs used to supply power.
Link aggregation	Advertises information on the port's load-sharing (link aggregation) capabilities and status.
Maximum frame size	Advertises the maximum supported frame size for a port to its neighbors. When jumbo frames are not enabled on the specified port, the TLV advertises a value of 1518. If jumbo frames are enabled, the TLV advertises the configured value for the jumbo frames.

Avaya–Extreme Networks Optional TLVs

The software supports a set of TLVs that are proprietary to Avaya and Extreme Networks. These TLVs advertise and receive information for Avaya voice over IP (VoIP) telephones, which include powered device (PD) information. Some TLVs are advertised by the switch, and some are advertised by the telephone. The switch starts advertising these proprietary TLVs when you enable LLDP and configure the specified TLVs to be advertised. The switch receives the proprietary TLVs when LLDP is enabled; you do not have to configure the switch to receive individual TLVs.

Table 44 describes the Avaya–Extreme Networks TLVs.

Table 44: Avaya–Extreme Networks TLVs

Name	Comments
PoE conservation level request	When the switch software needs to reduce power on a PoE-enabled port, this TLV advertises that request to the connected Avaya device.
Call server	The switch uses this TLV to advertise the IP addresses of up to 8 call servers to an Avaya phone.

Table 44: Avaya–Extreme Networks TLVs (Continued)

Name	Comments
File server	The switch uses this TLV to advertise the IP addresses of up to 4 file servers to an Avaya phone.
802.1Q framing	The switch uses this TLV to advertise information about Layer 2 priority tagging to an Avaya phone.
PoE Conservation level support	An Avaya phone uses this TLV to communicate the current power consumption level and current conservation level for the phone, including typical power value, maximum power value, and available conservation power levels.
IP phone address	An Avaya phone uses this TLV to communicate the IP address and mask configured in the phone, as well as a default gateway address.
CNA server	An Avaya phone uses this TLV to communicate the IP address of a Converged Network Analyzer (CNA).

LLDP MED Optional TLVs

LLDP Media Endpoint Discovery (MED) is an extension to LLDP that is published as standard ANSI/TIA-1057. LLDP MED TLVs advertise and receive information for endpoint devices, which can include PD information. Some TLVs are advertised by the switch, and some are advertised by the endpoint device.

Table 45 describes the LLDP MED TLVs.

Table 45: LLDP MED TLVs

Name	Comments
LLDP MED capabilities	The switch uses this TLV to advertise the switch LLDP MED capabilities to endpoint devices. This TLV must be configured for advertisement before any other LLDP MED TLVs can be configured for advertisement, and advertisement for all other MED TLVs, must be disabled before advertisement for this TLV can be disabled.
Network policy	The switch uses this TLV to advertise network policy information for specific applications to endpoint devices.  NOTE Network policies cannot be configured by SNMP-based management programs.
Location ID	The switch uses this TLV to advertise a location ID to an endpoint device.
Extended power via MDI	The switch uses this TLV to advertise a power information and settings to an endpoint device on a PoE-capable port.
Hardware revision	An endpoint device uses this TLV to advertise the configured hardware revision to the switch.
Firmware revision	An endpoint device uses this TLV to advertise the configured firmware revision to the switch.
Software revision	An endpoint device uses this TLV to advertise the configured software revision to the switch.
Serial number	An endpoint device uses this TLV to advertise the configured serial number to the switch.

Table 45: LLDP MED TLVs (Continued)

Name	Comments
Manufacturer name	An endpoint device uses this TLV to advertise the configured manufacturer name to the switch.
Model name	An endpoint device uses this TLV to advertise the configured model name to the switch.
Asset ID	An endpoint device uses this TLV to advertise the configured asset ID to the switch.

You must enable the LLDP-MED capabilities TLV for advertising *before* you configure any other LLDP MED TLVs for advertising. Likewise, when disabling LLDP MED TLV advertisement, you can disable the LLDP-MED capabilities TLV only *after* you have disabled advertisement for all other LLDP MED TLVs.

After the LLDP-MED capabilities TLV is configured for advertising, the switch can receive LLDP MED TLVs from endpoints; you do not have to configure the switch to receive individual TLVs.

The switch advertises LLDP MED TLVs only after the switch receives an LLDP MED TLV from an endpoint, and the switch only advertises on ports from which an LLDP MED TLV has been received. This approach prevents the switch from advertising LLDP MED TLVs to another switch, and it prevents the wasted bandwidth and processing resources that would otherwise occur.

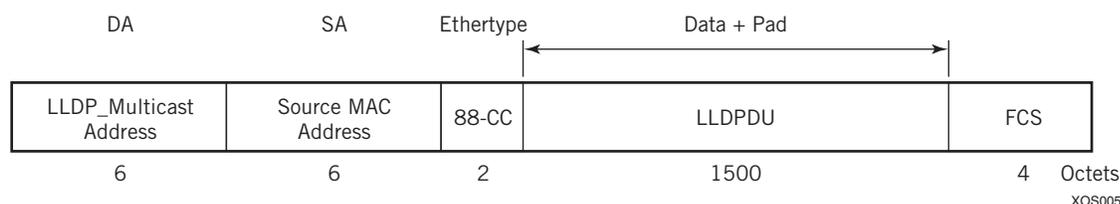
The LLDP MED protocol extension introduces a new feature called MED fast start, which is automatically enabled when the LLDP MED capabilities TLV is configured for advertisement. When a new LLDP MED-capable endpoint is detected, the switch advertises the configured LLDP MED TLVs every 1 second for the configured number of times (called the repeat count). This speeds up the initial exchange of LLDP MED capabilities. After the repeat count is reached, the LLDP MED TLVs are advertised at the configured interval.

**NOTE**

The fast-start feature is automatically enabled, at the default level of 3, when you enable the LLDP MED capabilities TLV on the port.

LLDP Packets

LLDP packets transport TLVs to other network devices (Figure 40). The LLDP packet contains the destination multicast address, the source MAC address, the LLDP EtherType, the LLDPDU data (which contains the TLVs), and a frame check sequence (FCS). The LLDP multicast address is defined as 01:80:C2:00:00:0E, and the EtherType is defined as 0x88CC.

Figure 40: LLDP Packet Format

The following characteristics apply to LLDP packets:

- They are IEEE 802.3 Ethernet frames.
- The frames are sent as untagged frames.
- The frames are sent with a link-local-assigned multicast address as the destination address.
- The Spanning Tree Protocol (STP) state of the port does not affect the transmission of LLDP frames.

The length of the packet cannot exceed 1500 bytes. As you add TLVs, you increase the length of the LLDP frame. When you reach 1500 bytes, the remaining TLVs are dropped. Extreme Networks recommends that you advertise information regarding only one or two VLANs on the LLDP port, to avoid dropped TLVs.

If the system drops TLVs because of exceeded length, the system logs a message to the EMS and the `show lldp statistics` commands shows this information under the `Tx Length Exceeded` field.

**NOTE**

The LLDPDU maximum size is 1500 bytes, even with jumbo frames enabled. TLVs that exceed this limit are dropped.

Transmitting LLDP Messages

You can configure each port to transmit LLDP messages, receive LLDP messages, or do both. When configured to transmit LLDP messages, the LLDP agent running on the switch passes serially through the list of ports that are enabled for LLDP. For each LLDP-enabled port, the switch periodically sends out an untagged LLDP packet that contains the mandatory LLDP TLVs as well as the optional TLVs that are configured for advertisement. These TLVs are advertised to all neighbors attached to the same network. LLDP agents cannot solicit information from other agents by way of this protocol.

**NOTE**

When both IEEE 802.1x and LLDP are enabled on the same port, LLDP packets are not sent until one or more clients authenticate a port.

Also, LLDP MED TLVs are advertised only after an LLDP MED TLV is received on a port that is configured for LLDP MED. (See “[LLDP MED Optional TLVs](#)” on page 392.)

The source information for TLVs is obtained from memory objects such as standard MIBs or from system management information. If the TLV source information changes at any time, the LLDP agent is notified. The agent then sends an update with the new values, which is referred to as a triggered update. If the information for multiple elements changes in a short period, the changes are bundled together and sent as a single update to reduce network load.

Receiving LLDP Messages

You can configure each port to transmit LLDP messages, receive LLDP messages, or do both. After you configure a port to receive TLVs, all LLDP TLVs are received (even if the LLDP MED capabilities TLV is not enabled). Each port can store LLDP information for a maximum of four neighbors.

**NOTE**

When both IEEE 802.1x and LLDP are enabled on the same port, incoming LLDP packets are accepted only when one or more clients are authenticated.

When configured to receive LLDP messages, the TLVs received at a port are stored in a standard Management Information Base (MIB), which makes it possible for the information to be accessed by an SNMP-compatible NMS such as Ridgeline. Unrecognized TLVs are also stored on the switch, in order of TLV type. TLV information is purged after the configured timeout interval, unless it is refreshed by the remote LLDP agent. You can also manually clear the LLDP information for one or all ports with the `clear lldp neighbors` command.

To display TLV information received from LLDP neighbors, use the `show lldp neighbors detailed` CLI command. (You must use the `detailed` variable to display all TLV information.)

LLDP Management

You manage LLDP using the CLI and/or an SNMP-compatible NMS such as Ridgeline. LLDP works concurrently with the Extreme Discovery Protocol (EDP). It also works independently; you do not have to run EDP to use LLDP.

LLDP configurations are saved across reboots when you issue the `save configuration` command. The switch logs EMS messages regarding LLDP, including when optional TLVs exceed the 1500-byte limit and when more than 4 neighbors are detected on a port.

After you enable LLDP, you can enable LLDP-specific SNMP traps; the traps are disabled by default. After you enable LLDP-specific traps, the switch sends all LLDP traps to the configured trap receivers. You can configure the period between SNMP notifications; the default interval is 5 seconds.

You can configure an optional TLV to advertise or not advertise the switch management address information to the neighbors on a port. When enabled, this TLV sends out the IPv4 address configured on the management VLAN. If you have not configured an IPv4 address on the management VLAN, the software advertises the system's MAC address. LLDP does not send IPv6 addresses in this field.

Configuring and Managing LLDP

The following sections describe how to configure LLDP on the switch:

- [Configuration Overview on page 396](#)
- [Enabling and Disabling LLDP on page 396](#)
- [Configuring LLDP Timers on page 397](#)
- [Configuring SNMP for LLDP on page 397](#)
- [Configuring Optional TLV Advertisements on page 398](#)
- [Clearing LLDP Neighbor Entries on page 404](#)
- [Unconfiguring LLDP on page 404](#)

Configuration Overview

You configure LLDP per port, and each port can store received information for a maximum of four neighbors.

**NOTE**

LLDP runs with link aggregation.

You can configure LLDP per port as follows:

- 1 Enable LLDP on the desired port(s) as described in [“Enabling and Disabling LLDP” on page 396](#).
- 2 If you want to change any default timer values, see [“Configuring LLDP Timers” on page 397](#).
- 3 Enable the SNMP traps and configure the notification interval as described in [“Configuring SNMP for LLDP” on page 397](#).
- 4 Configure any optional TLV advertisements as described in [“Configuring Optional TLV Advertisements” on page 398](#).

**NOTE**

By default, an LLDP-enabled port advertises the optional system description TLV. By default, all other optional TLVs are not advertised.

Enabling and Disabling LLDP

LLDP is disabled on all ports by default. When you enable LLDP on one or more ports, you select whether the ports will only transmit LLDP messages, only receive the messages, or both transmit and receive LLDP messages.

To enable LLDP, use the following command:

```
enable lldp ports [all | <port_list>] {receive-only | transmit-only}
```

After you enable LLDP, the following TLVs are automatically added to the LLDPDU:

- Chassis ID
- Port ID
- TTL
- System description
- End of LLDPDU

All of these, except the system description, are mandated by the 802.1ab standard and cannot be configured. For information on changing the system description TLV advertisement, see [“System Description TLV” on page 399](#).

To disable LLDP, use the following command:

```
disable lldp ports [all | <port_list>] {receive-only | transmit-only}
```

Configuring LLDP Timers

The LLDP timers apply to the entire switch and are not configurable by port. After you enable LLDP, LLDP timers control the time periods for the transmission and storage of LLDP TLVs as follows:

- Reinitialization period (default is 2 seconds)
- Delay between LLDP transmissions (default is 2 seconds)—applies to triggered updates, or updates that are initiated by a change in the topology
- Transmit interval (default is 30 seconds)—applies to messages sent periodically as part of protocol
- Time-to-live (TTL) value (default is 2 minutes)—time that the information remains in the recipient's LLDP database



NOTE

Once the LLDP MED TLVs begin transmitting (after detecting LLDP MED TLVs from a connected endpoint), those TLVs are also controlled by these timers.

When LLDP is disabled or if the link goes down, LLDP is reinitialized. The reinitialize delay is the number of seconds the port waits to restart the LLDP state machine; the default is 2 seconds.

To change the default reinitialize delay period, use the following command:

```
configure lldp reinitialize-delay <seconds>
```

LLDP messages are transmitted at a set interval; this interval has a default value of every 30 seconds. To change this default value, use the following command:

```
configure lldp transmit-interval <seconds>
```

The time between triggered update LLDP messages is referred to as the transmit delay, and the default value is 2 seconds. You can change the default transmit delay value to a specified number of seconds or to be automatically calculated by multiplying the transmit interval by 0.25. To change the value for the transmit delay, use the following command:

```
configure lldp transmit-delay [ auto | <seconds>]
```

Each LLDP message contains a TTL value. The receiving LLDP agent discards all LLDP messages that surpass the TTL value; the default value is 120 seconds.

The TTL is calculated by multiplying the transmit interval value and the transmit hold value; the default transmit hold value is 4. To change the default transmit hold value, use the following command:

```
configure lldp transmit-hold <hold>
```

Configuring SNMP for LLDP

By default, SNMP LLDP traps are disabled on all ports. To enable LLDP SNMP traps on one or more ports, use the following command:

```
enable snmp traps lldp {ports [all | <port_list>]}
```

The traps are only sent for those ports that are both enabled for LLDP and have LLDP traps enabled.

To disable the LLDP SNMP traps on one or more ports, use the following command:

```
disable snmp traps lldp {ports [all | <port_list>]}
```

The default value for the interval between SNMP LLDP trap notifications is 5 seconds. To change this interval for the entire switch, use the following command:

```
configure lldp snmp-notification-interval <seconds>
```

**NOTE**

If you want to send traps for LLDP MED, you must configure it separately. Use the `enable snmp traps lldp-med {ports [all | <port_list>]}` command to enable these traps.

Configuring Optional TLV Advertisements

By default, the ExtremeXOS software advertises the mandatory LLDP TLVs (which are not configurable) and the optional system description TLV (see “Supported Advertisements (TLVs)” on page 390). All other optional TLVs are not advertised.

You can choose to advertise or not advertise any optional TLV, but be aware that the total LLDPDU length, which includes the mandatory TLVs, cannot exceed 1500 bytes. Optional TLVs that cause the LLDPDU length to exceed the 1500-byte limit are dropped. You can see if the switch has dropped TLVs by referring to the EMS log or by issuing the `show lldp statistics` command.

This sections describe configuration for the following types of optional TLVs:

- [Configuring Standards-Based TLVs on page 398](#)
- [Configuring Avaya-Extreme TLVs on page 401](#)
- [Configuring LLDP MED TLVs on page 402](#)

Configuring Standards-Based TLVs

This section describes the following optional standards-based TLVs:

- [Port description TLV on page 398](#)
- [System name TLV on page 399](#)
- [System Description TLV on page 399](#)
- [System Capabilities TLV on page 399](#)
- [Management Address TLV on page 399](#)
- [VLAN Name TLV on page 399](#)
- [Port VLAN ID TLV on page 400](#)
- [Port and Protocol VLAN ID TLV on page 400](#)
- [MAC/PHY Configuration/Status TLV on page 400](#)
- [Power Via MDI TLV on page 400](#)
- [Link Aggregation TLV on page 401](#)
- [Maximum frame size TLV on page 401](#)

Port description TLV. The port description TLV advertises the ifDescr MIB object, which is the ASCII string you configure using the `configure ports display-string` command. If you have not configured this parameter, the TLV carries an empty string.

To control advertisement of the port description TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] port-description
```

System name TLV. The system name TLV advertises the configured system name for the switch. This is the sysName as defined in RFC 3418, which you can define using the `configure snmp sysname` command.

To control advertisement of the system name TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] system-name
```

System Description TLV. By default, the ExtremeXOS software advertises this TLV whenever you enable LLDP on a port, but you can disable advertisement. This TLV advertises `show version` command information similar to the following in the system description TLV:

```
ExtremeXOS version 11.2.0.12 v1120b12 by release-manager
on Fri Mar 18 16:01:08 PST 2005
```

To control advertisement of the system description TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] system-description
```

System Capabilities TLV. The system capabilities TLV advertises the capabilities of the switch and which of these capabilities are enabled. When so configured, the ExtremeXOS software advertises bridge capabilities. If IP forwarding is enabled on at least one VLAN in the switch, the software also advertises router capabilities.

To control advertisement of the system capabilities TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] system-
capabilities
```

Management Address TLV. The management address TLV advertises the IP address of the management VLAN. If the management VLAN does not have an assigned IP address, the management address TLV advertises the system's MAC address. LLDP does not recognize IPv6 addresses in this field.

To control advertisement of the management address TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] management-address
```



NOTE

The ExtremeXOS software sends only one management address TLV.

VLAN Name TLV. The VLAN name TLV advertises a VLAN name for one or more VLANs on the port.

You can advertise this TLV for tagged and untagged VLANs. When you enable this TLV for tagged VLANs, the TLV advertises the IEEE 802.1Q tag for that VLAN. For untagged VLANs, the internal tag is advertised.

If you do not specify a VLAN when you configure this TLV, the switch advertises all VLAN names on the specified ports. You can choose to advertise one or more VLANs for the specified ports by specifying the name of a VLAN in the configuration command. You can repeat the command to specify multiple VLANs.

To control advertisement of the port VLAN Name TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific
dot1 vlan-name {vlan [all | <vlan_name>]}
```



NOTE

Because each VLAN name requires 32 bits and the LLDPDU cannot exceed 1500 bytes, Extreme Networks recommends that you configure each port to advertise no more than one or two specific VLANs. Optional TLVs that cause the LLDPDU length to exceed the 1500-byte limit are dropped.

Port VLAN ID TLV. The port VLAN ID advertises the *untagged* VLAN on that port. Thus, only one port VLAN ID TLV can exist in the LLDPDU. If you configure this TLV and there is no untagged VLAN on the specified port, this TLV is not included in the LLDPDU.

To control advertisement of the port VLAN ID TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific
dot1 port-vlan-ID
```

Port and Protocol VLAN ID TLV. When configured for advertisement, this TLV advertises whether the specified VLANs on the specified ports support protocol-based VLANs or not.

If you do not specify a VLAN when you configure this TLV, the switch advertises protocol-based VLAN support for all VLAN names on the specified ports. You can choose to advertise support for one or more VLANs for the specified ports by specifying the name of a VLAN in the configuration command. You can repeat the configuration command to specify multiple VLANs.

Because all VLANs on Extreme Networks switches support protocol-based VLANs, the switch *always* advertises support for protocol-based VLANs for all VLANs for which this TLV is advertised. If no protocol-based VLANs are configured on the port, the switch sets the VLAN ID value to 0.

To control advertisement of the port and protocol VLAN ID TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific
dot1 port-protocol-vlan-ID {vlan [all | <vlan_name>]}
```



NOTE

Because a TLV is advertised for every VLAN that is advertised, and because the LLDPDU cannot exceed 1500 bytes, Extreme Networks recommends that you advertise this VLAN capability only for those VLANs that require it. Optional TLVs that cause the LLDPDU length to exceed the 1500-byte limit are dropped.

MAC/PHY Configuration/Status TLV. When configured for advertisement, this TLV advertises the autonegotiation and physical layer capabilities of the port. The switch adds information about the port speed, duplex setting, bit rate, physical interface, and autonegotiation support and status.

To control advertisement of the port and protocol MAC/PHY configuration/status TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific
dot3 mac-phy
```

Power Via MDI TLV . When configured for advertisement on Ethernet (PoE) or PoE+ ports, this TLV advertises the device type, power status, power class, and pin pairs used to supply power.

The device type field contains a binary value that represents whether the LLDP-compatible device transmitting the LLDPDU is a power sourcing entity (PSE) or power device (PD), as listed in [Table 46](#).

Table 46: Power Management TLV Device Information

Value	Power source
0	PSE device
1	PD device
2-3	Reserved

To control advertisement of the power via MIDI TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific dot3 power-via-mdi {with-classification}
```

Refer to for “[Configuring Avaya-Extreme TLVs](#)” on page 401 and “[Configuring LLDP MED TLVs](#)” on page 402 more information on power-related TLVs.

Link Aggregation TLV. When configured for advertisement, this TLV advertises information on the port’s load-sharing (link aggregation) capabilities and status.

To control advertisement of the link aggregation TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific dot3 link-aggregation
```

Maximum frame size TLV. When configured for advertisement, this TLV advertises the maximum supported frame size for a port to its neighbors. When jumbo frames are not enabled on the specified port, the TLV advertises a value of 1518. If jumbo frames are enabled, the TLV advertises the configured value for the jumbo frames.

To control advertisement of the maximum frame size TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific dot3 max-frame-size
```

Configuring Avaya-Extreme TLVs

This section describes the following optional proprietary Avaya-Extreme Networks TLVs that you can configure the switch to transmit:

- [PoE Conservation Level Request TLV on page 401](#)
- [Call Server TLV on page 402](#)
- [File Server TLV on page 402](#)
- [802.1Q Framing TLV on page 402](#)



NOTE

You can display the values for these TLVs using the `show lldp neighbors detailed` command.

PoE Conservation Level Request TLV. When configured for advertisement, this TLV advertises a request to the connected PD to go into a certain power conservation level or go to the maximum conservation level. This LLDP TLV is sent out only on PoE-capable Ethernet ports.

By default, the requested conservation value on this proprietary LLDP TLV is 0, which is no power conservation. You can change this level temporarily using a network station or SNMP with the MIB; this change is *not* saved across a reboot.

To control advertisement of the PoE conservation level request TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific
avaya-extreme poe-conservation-request
```

Call Server TLV. When configured for advertisement, this TLV advertises the IP addresses of up to 8 call servers. Avaya phones use this addressing information to access call servers.

To control advertisement of the call server TLV and define call server addresses, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific
avaya-extreme call-server <ip_address_1> {<ip_address_2> {<ip_address_3>
{<ip_address_4> {<ip_address_5> {<ip_address_6> {<ip_address_7> {ip_address_8}}}}}}}}
```

File Server TLV. When configured for advertisement, this TLV advertises the IP addresses of up to 4 file servers. Avaya phones use this address information to access file servers.

To control advertisement of the file server TLV and define file server addresses, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific
avaya-extreme file-server <ip_address_1> {<ip_address_2> {<ip_address_3>
{<ip_address_4>}}}
```

802.1Q Framing TLV. When configured for advertisement, this TLV advertises information about Layer 2 priority tagging for Avaya phones.

To control advertisement of the 802.1Q framing TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific
avaya-extreme dot1q-framing [tagged | untagged | auto]
```



NOTE

For this command to work, you must have previously enabled both the `configure lldp ports vendor-specific med capabilities` and the `configure lldp ports vendor-specific med policy application` commands. (See “Configuring LLDP MED TLVs” on page 402 for complete information.)

Configuring LLDP MED TLVs



NOTE

You must configure the LLDP MED capabilities TLV to advertise before any of the other LLDP MED TLVs can be configured. Also, this TLV must be set to no-advertise after all other MED TLVs are set to no-advertise.

After you enable an LLDP MED TLV, the switch waits until it detects a MED-capable device *before* it begins transmitting the configured LLDP MED TLVs. This approach assures that network connectivity devices advertise LLDP MED TLVs only to end devices and not to other network connectivity devices.

The following sections describe LLDP MED TLVs and features:

- [LLDP MED capabilities TLV on page 403](#)
- [LLDP MED Fast-Start Feature on page 403](#)
- [Network policy TLV on page 403](#)
- [Location identification TLV on page 403](#)
- [Extended power-via-MDI TLV on page 404](#)
- [SNMP Traps for LLDP MED on page 404](#)



NOTE

You can display the values for these TLVs using the `show lldp neighbors detailed` command.

LLDP MED capabilities TLV. This TLV advertises the LLDP MED capabilities of the switch and must be enabled before any of the other LLDP MED TLVs can be enabled.

To enable configuration and transmission of any other LLDP MED TLV and to determine the LLDP MED capabilities of endpoint devices, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific med capabilities
```

LLDP MED Fast-Start Feature. The LLDP MED fast-start feature allows you to increase the learning speed of the switch for LLDP MED TLVs. The fast-start feature is automatically enabled once you enable the LLDP MED capabilities TLV.

By default, the switch sends out the LLDPDU every second for up to the default repeat count, which is 3. Once the repeat count is reached, the configured transmit interval value is used between LLDPDUs. You can configure the repeat count to any number in the range of 1 to 10.

To configure the LLDP fast-start feature, use the following command:

```
configure lldp med fast-start repeat-count <count>
```

Network policy TLV. This TLV advertises which VLAN an endpoint should use for the specified application.

You can configure only one instance of an application on each port, and you can configure a maximum of 8 applications, each with its own DSCP value and/or priority tag.

To control advertisement and configure one or more network policy TLVs for a port, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific med policy application [voice | voice-signaling | guest-voice | guest-voice-signaling | softphone-voice | video-conferencing | streaming-video | video-signaling] vlan <vlan_name> dscp <dscp_value> {priority-tagged}
```

Location identification TLV. This TLV advertises one of three different location identifiers for a port, each with a different format, as follows:

- Coordinate based, using a 16-byte hexadecimal string
- Civic-based, using a hexadecimal string with a minimum of 6 bytes
- ECS ELIN, using a numerical string with a range of 10 to 25 characters.

To control advertisement and configure location information, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific  
med location-identification [coordinate-based <hex_value> | civic-based <hex_value> |  
ecs-elin <elin>]
```

Extended power-via-MDI TLV. This TLV advertises fine-grained power requirement details, including the PoE settings and support.

You can enable this TLV *only* on PoE-capable ports; the switch returns an error message if you attempt to transmit this LLDP TLV over a non-PoE-capable port.

To control advertisement for this TLV, use the following command:

```
configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific  
med power-via-mdi
```

SNMP Traps for LLDP MED. To receive SNMP traps on the LLDP MED, you must enable these separately from the other LLDP traps. (See “Configuring SNMP for LLDP” on page 397).

To enable the LLDP MED SNMP traps, issue the following command:

```
enable snmp traps lldp-med {ports [all | <port_list>]}
```

To disable the LLDP MED SNMP traps, issue the following command:

```
disable snmp traps lldp-med {ports [all | <port_list>]}
```

Clearing LLDP Neighbor Entries

To remove the LLDP entries received on one or more ports from the switch database, use the following command:

```
clear lldp neighbors [all | port <port_list>]
```

Unconfiguring LLDP

To unconfigure the LLDP timers, use the following command:

```
unconfigure lldp
```

This command returns the LLDP timers to default values; LLDP remains enabled, and all the configured TLVs are still advertised.

To leave LLDP enabled, but reset the advertised TLVs to the five default TLVs, use the following command, and specify the affected ports:

```
unconfigure lldp port [all | <port_list>]
```

Displaying LLDP Information

The following sections describe how to display LLDP information for the switch:

- “Displaying LLDP Port Configuration Information and Statistics” on page 405
- “Displaying LLDP Information Collected from Neighbors” on page 405

The system displays information on the LLDP status and statistical counters of the ports, as well as about the LLDP advertisements received and stored by the system. You can display information on the LLDP port configuration and on the LLDP neighbors detected on the port.

Displaying LLDP Port Configuration Information and Statistics

To display LLDP port configuration information, use the following command:

```
show lldp {port [all | <port_list>]} {detailed}
```

To display the statistical counters related to the LLDP port, use the following command:

```
show lldp {port [all | <port_list>]} statistics
```

Displaying LLDP Information Collected from Neighbors

To display information collected from LLDP neighbors, use the following command:

```
show lldp neighbors
```



NOTE

You must use the detailed option to display information on the proprietary Avaya-Extreme Networks TLVs and the LLDP MED TLVs.

9 OAM

CHAPTER

Operation, Administration, and Maintenance (OAM) includes functions used to detect network faults, measure network performance and distribute fault-related information.

This chapter includes the following sections:

- [CFM on page 407](#)
- [Y.1731—Compliant Performance Monitoring on page 419](#)
- [EFM OAM—Unidirectional Link Fault Management on page 430](#)
- [Bidirectional Forwarding Detection \(BFD\) on page 432](#)

CFM

Connectivity Fault Management (CFM), discussed in the IEEE 802.1Q-2011 standard and originally specified in the IEEE 802.1ag-2007 standard, allows you to detect, verify, and isolate connectivity failures in virtual bridged LANs. Part of this specification is a toolset to manually check connectivity, which is sometimes referred to as Layer 2 ping.



NOTE

The ExtremeXOS implementation of CFM is based on the IEEE 802.1Q-2011 standard.

There is no direct interaction between CFM and other Layer 2 protocols; however, blocked Spanning Tree Protocol (STP) ports are taken into consideration when forwarding CFM messages.

This section includes the following topics:

- [Overview on page 408](#)
- [Ping and Traceroute on page 412](#)
- [Supported Instances for CFM on page 412](#)
- [Configuring CFM on page 413](#)
- [Displaying CFM on page 418](#)
- [CFM Example on page 418](#)

Overview



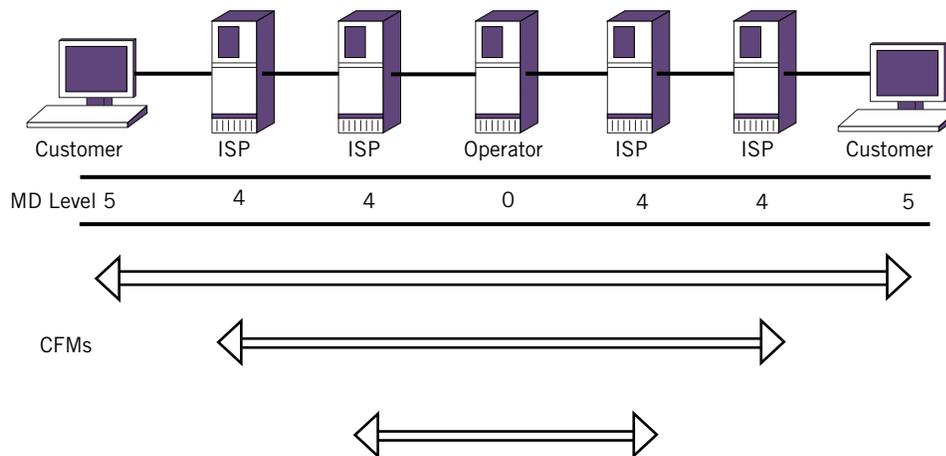
NOTE

Extreme Networks uses values defined in IEEE 802.1Q-2011 for the MAC addresses and Ethernet type for CFM.

You create hierarchical networks, or domains, and test connectivity within a domain by sending Layer 2 messages, known as Connectivity Check Messages (CCMs).

Figure 41 shows an example of hierarchical CFM domains.

Figure 41: CFM Hierarchical Domains Example



EX_cfm_0041



NOTE

The arrows in Figure 41 indicate the span that CCM messages take, not the direction. (See Table 47 for more information on spans for CCM messages.)

To achieve this hierarchical connectivity testing, you create and configure the following entities:

- Maintenance domains, or domains
- Maintenance domain (MD) level; a unique hierarchical numeric value for each domain
- Maintenance associations (MAs)
- Maintenance points (MPs), which are the following
 - Maintenance end points (MEPs), which are one of the following types:
 - UP MEPs
 - DOWN MEPs
 - Maintenance intermediate points (MIPs)



NOTE

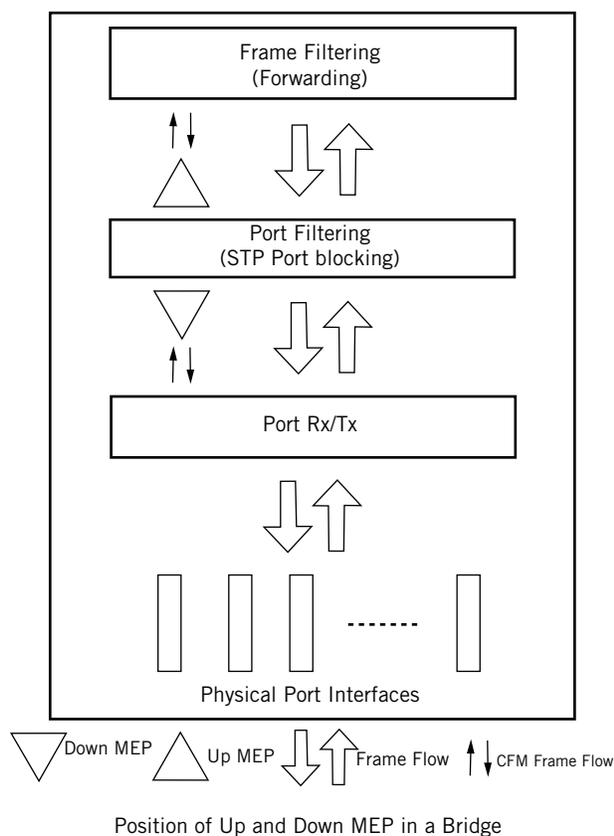
The CFM filter function (CFF) is no longer supported from ExtremeXOS 12.1. The functionality of CFF is implicitly performed by MEPs.

An UP MEP sends CFM frames toward the frame filtering entity, which forwards the frames to all other ports of a service instance other than the port on which the UP MEP is configured. This is similar to how the frame filtering entity forwards a normal data frame, taking into account the port's STP state. For an UP MEP, a CFM frame exits from a port if only if the STP state of the port is in the forwarding state.

A DOWN MEP sends CFM frames directly to the physical medium without considering the port STP state. For a DOWN MEP, a CFM frame exits from a port even if the port STP state is in blocking state.

Figure 42 shows the concept of UP and DOWN MEP at logical level:

Figure 42: CFM UP and DOWN MEP at the Logical Level



EX_cfm_0043

You must have at least one MP on an intermediate switch in your domain. Ensure that you map and configure all ports in your domain carefully, especially the UP MEPs and the DOWN MEPs. If these are incorrectly configured, the CCMs are sent in the wrong direction in your network, and you will not be able to test the connectivity within the domain.

You can have up to eight domains on an Extreme Networks switch. A domain is the network or part of the network for which faults are to be managed; it is that section where you are monitoring Layer 2 connectivity. A domain is intended to be fully connected internally.



NOTE

Domains may cross VR boundaries; domains are not virtual router-aware.

You assign each domain an MD level, which functions in a hierarchy for forwarding CFM messages. The MD levels are from 0 to 7. The *highest* number is *superior* in the CFM hierarchy.

The IEEE standard 802.1Q-2011 recommends assigning different MD levels to different domains for different network users, as follows:

- 5 to 7 for end users
- 3 and 4 for Internet service providers (ISPs)
- 0 to 3 for operators (entities carrying the information for the ISPs)

All CFM messages with a superior MD level (numerically higher) pass throughout domains with an inferior MD level (numerically lower). CFM messages with an inferior MD level are not forwarded to domains with a superior MD level. Refer to [Table 47](#) for an illustration of domains with hierarchical MD levels.

Table 47: MD Levels and Recommended Use

MD level	0	1	2	3	4	5	6	7
Use	Operator			Service provider		Customer		
Superiority	Most inferior	< ----- Inferior / Superior ----- >						Most superior

Within a given domain, you associate maintenance associations (MAs). Extreme Networks' implementation of CFM associates MAs with service instances (a service instance can be a VLAN, VMAN, BVLAN, or SVLAN). All of the ports in that VLAN service instance are now in that MA and its associated domain. In general, you should configure one MIP on each intermediate switch in the domain and a MEP on every edge switch.

Each MA associates with one service instance, and a service instance can be associated with more than one MA. The MA is unique within the domain. One switch can have 8 domains, 128 ports, 256 associations (see ["Supported Instances for CFM"](#) on page 412 for supported CFM elements).



NOTE

You cannot associate the Management VLAN with an MA or a domain.

You assign the MPs to ports: UP MEPs, DOWN MEPs, and MIPs. These various MPs filter or forward the CFM messages to test the connectivity of your network.

Each configured MEP periodically sends out a Layer 2 multicast or unicast CCM message. The destination MAC address in the CCM frame is from a multicast MAC address range that is reserved for CFM messages. Each MEP must have a MEP ID that is unique within the MA. The MEPs send the CCM messages differently, depending on the configuration, as follows:

- The DOWN MEPs sends out a single CCM message.
- The UP MEPs potentially sends the CCM message to all ports on the service instance (MA)—except the sending port—depending on the MPs configured on the outgoing ports.

**NOTE**

Ensure that you configured the UP and DOWN MEPs correctly, or the CCMs will flow in the wrong direction through the domain and not allow connectivity testing.

MIPs define intermediate points within a domain. MIPs relay the CCM messages to the next MIP or MEP in the domain.

You configure the time interval for each MEP to send a CCM. Extreme Networks recommends setting this interval for at least 1 second. Each MEP also makes a note of what port and what time it *received* a CCM. This information is stored in the CCM database.

Each CCM has a time-to-live (TTL) value also noted for that message. This TTL interval is 3.5 times the CCM transmission interval you configured on the switch that is originating the CCM. After the TTL expires, the connectivity is considered broken, and the system sends a message to the log. One important result of the continual transmission of CCM frames is that the MAC address of the originating MEP is known to all MPs in the association.

**NOTE**

All MEPs in an MA must be configured with the same CCM transmission interval.

The MD values are from 0 to 7; in the hierarchy, the MD level of 0 is lowest and 7 is highest.

Not all combinations of MPs are allowed on the same port within an MA; only the following combinations can be on the same port within an MA:

- UP MEP and MIP
- DOWN MEP with neither UP MEP nor MIP

CFM protocol imposes the following MP restrictions within an MA on a switch:

- MA can have either up MEP or down MEP and not both.
- MA can have multiple Down MEPs.
- Only one Up MEP per MA.
- MA can have both up MEP and MIP.
- MA cannot have MIP if down MEP is present.
- Down MEPs on regular ports are created in hardware for all CCM intervals 3.3 msec–600000 sec on Summit X460, E4G-400, and E4G-200.
- Up MEPs and MEPs on LAG ports are created in software with CCM intervals 100 msec–600000 sec on all platforms.
- Dynamic Remote MEP learning is not supported for the MEPs created in hardware. You must explicitly create static Remote MEPs.
- Sender-Id-IP Address cannot be configured for the MEPs created in hardware.
- Unicast CCM transmission is not supported by the MEPs created in hardware.
- Domain name format should be of string type to create any MEPs in hardware in that domain.
- The CCM transmission state is disabled by default for the MEPs created in hardware by the CFM user interface.

- The CCM transmission state is enabled by default for the MEPs created in hardware by CFM clients like ERPS.
- The hardware Remote MEP status appears in “show cfm detail”. It is also forwarded to the client if created by a client like ERPS.
- CFM objects like domain, association, MEP, Remote MEP created by a client are not saved by dot1ag.

**NOTE**

An MA can have an UP MEP in one switch and a DOWN MEP on another switch for the same MA.

Ping and Traceroute

When operators see a connectivity fault message from CFM in the system log, they can send a loopback message (LBM) or a link trace message (LTM). These are also referred to as a Layer 2 ping or a traceroute message. You can send with an LBM or an LTM *only* from a MEP (either UP or DOWN).

You can only send a ping from a MEP, and you ping to the unique system MAC address on the switch you are testing connectivity to. The operator sends out a unicast LBM, and the first MIP or MEP on the switch with the destination MAC address matching the embedded MAC address replies with an LBR.

You can only send a traceroute (or LTM) from a MEP. You send the traceroute to the unique system MAC address on the switch to which you are testing connectivity. The system sends out an LTM to the special multicast address. If the destination address is not present in the FDB, the LTM is flooded on all the ports in the MIP node. Each MIP in the path passes the frame only in the direction of the path and sends a link trace reply (LTR) message back to the originating with information that the LTM passed. The traceroute command displays every MIP along the path (see [traceroute mac port](#)).

Supported Instances for CFM

Table 48 displays the CFM support in ExtremeXOS.

Table 48: ExtremeXOS CFM Support

Item	Limit	Notes
Domains	8	Per switch; one for each MD level
Associations (MAs)	256	Per switch
UP MEPs	32 on Summit Family switches, SummitStack, E4G-200, E4G-400, and BlackDiamond 8000 series modules.	Per switch
DOWN MEPs	256 hardware-placed MEPs ^a on Summit series X460, E4G-400, E4G-200 (non-load shared ports)	Per switch
	32 on Summit series X460, E4G-400, E4G-200 (load shared ports)	
	32 on other Summit family switches and Black Diamond 8000 series	
MIPs	32 on Summit Family switches, SummitStack and BlackDiamond 8000 series modules.	Per switch

Table 48: ExtremeXOS CFM Support (Continued)

Item	Limit	Notes
Total CFM ports	128	Per switch; total number of all ports for all service instances assigned to an MA (see <code>show cfm</code> command for ports configured for CFM)
Entries in the CCM database	2000	Number of remote end points stored in a CCM database on each MEP; 64 end points per MEP (additional CCMs discarded after this limit is reached)
CFM Segments	1000	Maximum number of CFM segments for Y.1731.
CFM Groups	1000	Maximum number of CFM groups.

- a. RMEPs need to be explicitly configured for hardware MEPs. Unlike software MEPs, hardware MEPs do not support dynamic RMEP learning.

**NOTE**

The total number of CFM ports is a guideline, not a limit enforced by the system.

CFM Groups

Loop detection protocols like EAPS/ERPS want to depend upon CFM to detect link status for faster failover recovery. They register with LMEP and RMEP objects created by CFM in order to receive the link status event notifications to take the necessary action.

Currently LMEP is identified with domain, association, port, MEPIId quadruples. And RMEP is identified with domain, association, LMEP, RMEPIId quadruples. Each LMEP can be tied up to multiple RMEPs. So applications need to configure domain, association, LMEP and RMEPs through a client/server interface.

To simplify this, CFM provides a simple API to client applications to register/deregister CFM with a specified string name. The string name can be identified as a CFM group that binds an LMEP to multiple RMEPs. The group name is unique across the switch. Each application can create its own group for a required LMEP/RMEP combination.

You can associate a group to each LMEP created on a port. There exists a one-to-one relationship between LMEP-port-group. Whenever CFM stops receiving CCMs on this port, it informs a group DOWN event to registered clients like ERPS/EAPS. Whenever CFM starts receiving the CCMs again on this port, a group UP event is sent to registered clients.

Configuring CFM

To configure CFM, you create a maintenance domain and assign it a unique MD level. Next, you associate MAs with the specified domain and assign MPs within that MA. Optionally, you can configure the transmission interval for the CCMs, destination MAC type for an MA and remote MEPs statically in an MA.

If an MEP fails to receive a CCM before the last advertised TTL value expires, the system logs a message. After the network administrator sees the system log message, he can send a Layer 2 ping and/or a traceroute message to isolate the fault.

**NOTE**

CFM does not use ACL; there are no additional ACL entries present for CFM in the `show access-list dynamic` command output.

This section describes the following topics:

- [Creating Maintenance Domains on page 414](#)
- [Creating and Associating MAs on page 415](#)
- [Creating MPs and the CCM Transmission Interval on page 416](#)
- [Configuring EAPS for CFM Support on page 417](#)
- [Monitoring CFM in EAPS on page 417](#)
- [Executing Layer 2 Ping and Traceroute Messages on page 418](#)

Creating Maintenance Domains

You create maintenance domains (MDs), or domains, and assign a unique MD level at that time. Available MD levels are numbered from 0 to 7. *Higher* numerical values are *superior* MD levels in the CFM hierarchy. Each switch can have a total of eight domains; each with a unique MD level.

You can name domains using any one of the following three formats:

- **Simple string**
Use an alphanumeric character string with a maximum of 43 characters.
- **Domain name server (DNS) name**
Use an alphanumeric character string with a maximum of 43 characters.
- **MAC address plus 2-octet integer**
Use a MAC address and a 2-octet integer. The display format is `XX.XX.XX.XX.XX.XX.YYY`, where X is the MAC address, and Y is the 2-octet integer. For example, a domain name in this format using 123 as the 16-bit unsigned integer appears as follows: `00:11:22:33:44:55.123`.

**NOTE**

Whatever convention you choose, you must use that same format throughout the entire domain.

The CFM messages carry the domain name, so the name and naming format must be identical to be understood throughout the domain. You can, however, use different naming conventions on different domains on one switch (up to eight domains allowed on one switch). User-created CFM names are not case sensitive.

To create a domain and assign an MD level using the simple string convention, use the following CLI command:

```
create cfm domain string <str_name> md-level <level>
```

To create a domain and assign an MD level using the DNS convention, use the following CLI command:

```
create cfm domain dns <name> md-level <level>
```

To create a domain and assign an MD level using the MAC address convention, use the following CLI command:

```
create cfm domain mac <mac-addr> <int> md-level <level>
```

Although you assign an MD level to the domain when you create that domain, you can change the MD level on an existing domain by using the following command:

```
configure cfm domain <domain_name> md-level <level>
```

To delete a domain, use the following command:

```
delete cfm domain <domain>
```

Creating and Associating MAs

Within a given domain, you associate maintenance associations (MAs). Extreme Networks' implementation of CFM associates MAs with service instances. All of the ports in that service instance are now in that MA and its associated domain.

Each MA associates with one service instance, and each service instance may associate with more than one MA; you can configure more than one MAs in any 1 domain. Like the domains, ExtremeXOS supports multiple formats for naming the MA. The following formats are supported for naming the MAs:

- Character string
- 2-octet integer
- RFC 2685 VPN
- VLAN ID

To add an MA to a domain using the character string format, use the following command:

```
configure cfm domain <domain_name> add association string <name> [vlan <vlan_name>|vman <vman_name>]
```

To add an MA to a domain using the 2-octet integer format, use the following command:

```
configure cfm domain <domain_name> add association integer <int> [vlan <vlan_name>|vman <vman_name>]
```

To add an MA to a domain using the RFC 2685 VPN ID format, use the following command:

```
configure cfm domain <domain_name> add association vpn-id oui <oui> index <index> [vlan <vlan_name>|vman <vman_name>]
```

To add an MA to a domain using the VLAN ID format, use the following command:

```
configure cfm domain <domain_name> add association vlan-id <vlanid> [vlan <vlan_name>|vman <vman_name>]
```

To delete an MA from a domain, use the following command:

```
configure cfm domain <domain_name> delete association <association_name>
```

In addition to supporting multicast destination MAC address for CCM and LTM frames specified by the 802.1ag standard, ExtremeXOS CFM supports the use of a unicast destination address for CCM and

LTM frames. This allows the support of a CFM operation in a network where use of multicast address is prohibited. To configure the destination MAC address type for an MA, use the following command:

```
configure cfm domain <domain-name> association <association_name> destination-mac-type
[unicast | multicast]
```

ExtremeXOS CFM supports configuring remote MEPs statically for CFM operation where dynamic discovery of MEPs in an MA using multicast address is prohibited. Use the following command to add a remote MEP to an MA statically:

```
configure cfm domain <domain-name> association <association_name> add remote-mep
<mepid> { mac-address <mac_address> }
```

To delete a remote MEP from an MA, use the following command:

```
configure cfm domain <domain-name> association <association_name> delete remote-mep
<mepid>
```

To configure a remote MEP MAC address, use the following command:

```
configure cfm domain <domain-name> association <association_name> remote-mep <mepid>
mac-address <mac_address>
```

Creating MPs and the CCM Transmission Interval

Within an MA, you configure the following MPs:

- Maintenance end points (MEPs), which are one of the following types:
 - UP MEPs—transmit CCMs and maintain CCM database
 - DOWN MEPs—transmit CCMs and maintain CCM database
- Maintenance intermediate points (MIPs)—pass CCMs through

Each MEP must have an ID that is unique for that MEP throughout the MA.

To configure UP and DOWN MEPs and its unique MEP ID, use the following command:

```
configure cfm domain <domain_name> association <association_name> [ports <port_list>
add [[end-point [up|down] <mepid> {group <group_name>}] | [intermediate-point]]
```

To change the MEP ID on an existing MEP, use the following command:

```
configure cfm domain <domain-name> association <association_name> ports <port_list>
end-point [up | down] mepid <mepid>
```

To delete UP and DOWN MEPs, use the following command:

```
configure cfm domain <domain_name> association <association_name> [ports <port_list>
delete [[end-point [up|down]] | [intermediate-point]]
```

To configure a MIP, use the following command:

```
configure cfm domain <domain_name> association <association_name> [ports <port_list>
add [[end-point [up|down] <mepid> {group <group_name>}] | [intermediate-point]]
```

To delete a MIP, use the following command:

```
configure cfm domain <domain_name> association <association_name> [ports <port_list>
delete [[end-point [up|down]] | [intermediate-point]]
```

To configure the transmission interval for the MEP to send CCMs, issue the following command:

```
configure cfm domain <domain_name> association <association_name> {ports <port_list>
end-point [up | down]} transmit-interval [3|10|100|1000|10000|60000|600000]
```

To unconfigure the transmission interval for the MEP to send CCMs and return it to the default, use the following command:

```
unconfigure cfm domain <domain_name> association <association_name> {ports <port_list>
end-point [up | down]} transmit-interval
```

To enable or disable a MEP, use the following command:

```
configure cfm domain <domain_name> association <association_name> ports <port_list>
end-point [up | down] [enable | disable]
```

Configuring EAPS for CFM Support

Assign MEP Group Names to New MEP. To assign MEP Group name when creating a MEP, perform the following task:

```
configure cfm domain <domain_name> association <association_name> [ports
<port_list> add [[end-point [up|down] <mepid> {group <group_name>} ] |
[intermediate-point]]
```

Assign MEP Group Name to Existing MEP. To assign a MEP Group name to an existing MEP, perform the following task:

```
configure cfm domain <domain_name> association <association_name> ports
<port_list> end-point [up|down] [add|delete] group <group_name>
```

Add a RMEP to MEP Group. To add specific RMEPs for a MEP Group to monitor, perform the following task:

```
configure cfm group <group_name> [add|delete] rmep <mepid>
```

Monitoring CFM in EAPS

Display MEP Groups. To display MEP groups, issue the following command:

```
show cfm groups {<group_name>}
```

```
X480-48t.1 # sh cfm groups
```

```
Group : eapsCfmGrp1      Status : UP
      Local MEP       : 11      port   : 41
      Remote MEPs     : 10
      Client(s)       : eaps
      Domain          : MD1
      Association     : MD1v2
Group : eapsCfmGrp2      Status : UP
      Local MEP       : 12      port   : 31
      Remote MEPs     : 13
      Client(s)       : eaps
      Domain          : MD1
```

Association : MD1v2

Executing Layer 2 Ping and Traceroute Messages

If the system logs a missed CCM message, the operator can use Layer 2 ping and traceroute messages to isolate the fault. (See “Ping and Traceroute” on page 412 for information on how each MP handles these messages.)



NOTE

You must have all the CFM parameters configured on your network before issuing the ping and traceroute messages.

To send a Layer 2 ping, use the following command:

```
ping mac <mac> port <port> {domain} <domain_name> {association} <association_name>
```

To send a Link Trace Message (LTM) and receive information on the path, use the following command:

```
traceroute mac <mac> {up-end-point} port <port> {domain} <domain_name> {association}
<association_name> {ttl <ttl>}
```

Displaying CFM

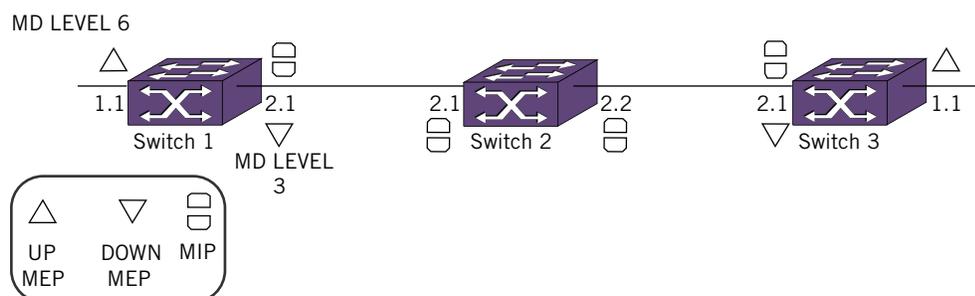
To verify your CFM configuration, you can display the current CFM configuration using the `show cfm` command. The information this command displays includes the total ports configured for CFM, the domain names and MD levels, the MAs and associated service instances, and the UP and DOWN MEPs.

To display the CCM database for each MEP, use the `show cfm detail` command.

CFM Example

As shown in Figure 43, this example assumes a simple network; this example assumes that CFM is configured on the access switches, as well as the necessary VMANs configured with the ports added. This example shows a VMAN associated with two maintenance domains and two different MAs. UP MEPs are configured for an MA with MD level 6 and DOWN MEPs are configured for an MA with MD level 3.

Figure 43: CFM Configuration Example



EX_cfm_0040

To configure switch 1 for this example, use the following CLI commands:

```
create cfm domain string cust-xyz-d6 md-level 6
configure cfm domain cust-xyz-d6 add association string cust-xyz-d6-m100 vman m100
configure cfm domain cust-xyz-d6 association cust-xyz-d6-m100 port 1:1 add end-point
up 10
configure cfm domain cust-xyz-d6 association cust-xyz-d6-m100 port 2:1 add
intermediate-point
create cfm domain string core-d3 md-level 3
configure cfm domain core-d3 add association string core-d3-m100 vman m100
configure cfm domain core-d3 association core-d3-m100 port 2:1 add end-point down 10
```

To configure switch 2 for this example, use the following CLI commands:

```
create cfm domain string core-d3 md-level 3
configure cfm domain core-d3 add association string core-d3-m100 vman m100
configure cfm domain core-d3 association core-d3-m100 port 2:1 add intermediate-point
configure cfm domain core-d3 association core-d3-m100 port 2:2 add intermediate-point
```

To configure switch 3 for this example, use the following CLI commands:

```
create cfm domain string cust-xyz-d6 md-level 6
configure cfm domain cust-xyz-d6 add association string cust-xyz-d6-m100 vman m100
configure cfm domain cust-xyz-d6 association cust-xyz-d6-m100 port 1:1 add end-point
up 20
configure cfm domain cust-xyz-d6 association cust-xyz-d6-m100 port 2:1 add
intermediate-point
create cfm domain string core-d3 md-level 3
configure cfm domain core-d3 add association string core-d3-m100 vman m100
configure cfm domain core-d3 association core-d3-m100 port 2:1 add end-point down 20
```

To display the group database, use the `show cfm groups` command.

Y.1731—Compliant Performance Monitoring

Compliant performance monitoring is based on the ITU-T Y.1731 standard and deals with the Ethernet Delay Measurement (ETH-DM) function and Ethernet Frame-Loss Measurement (ETH-LM).

This section describes the following topics:

- [Frame-Delay Measurement on page 419](#)
- [Frame-Loss Measurement on page 423](#)
- [Configuring a CFM Segment on page 425](#)

Frame-Delay Measurement

ExtremeXOS software supports:

- Two-way delay measurement—Delay Measurement Message (DMM) and Delay Measurement Reply (DMR)
- Continuous (proactive) measurement of frame delay and frame delay variation
- On-demand measurement of frame delay and frame delay variation

By default, the transmission is not enabled. You must explicitly enable the DMM transmission for a CFM segment, either as continuous or on-demand mode.

This measurement is done between two specific end points within an administrative domain. Frame delay and frame delay variation measurements are performed in a maintenance association end point (MEP) by sending and receiving periodic frames with ETH-DM information to and from the peer end point during the diagnostic interval.

When a CFM segment is enabled to generate frames with ETH-DM information, it periodically sends frames with ETH-DM information to its peer in the same maintenance association (MA) and expects to receive frames with ETH-DM information from its peer in the same MA.

Specific configuration information that is required by a peer to support ETH-DM is as follows:

- Maintenance domain (MD) level—The MD level at which the peer exists
- Priority—The priority of the frames with ETH-DM information
- Drop eligibility—Frames with ETH-DM information that are always marked as drop ineligible
- Transmission rate
- Total transmit interval

A node transmits frames with ETH-DM information with the following information element:

TxTimeStampf: Timestamp at the transmission time of the ETH-DM frame

RxTimeStampt: Timestamp at which the switch receives the DMR back

Whenever a valid DMM frame is received by the peer, a DMR frame is generated and transmitted to the requesting node. A DMM frame with a valid MD level and a destination MAC address equal to the receiving node's MAC address is considered to be a valid DMM frame. Every field in the DMM frame is copied to the DMR frame with the following exceptions:

- The source and destination MAC addresses are swapped.
- The OpCode field is changed from DMM to DMR.

The switch makes two-way frame delay variation measurements based on its ability to calculate the difference between two subsequent two-way frame delay measurements. To allow a more precise two-way frame delay measurement, the peer replying to the frame with ETH-DM request information may include two additional timestamps in the ETH-DM reply information:

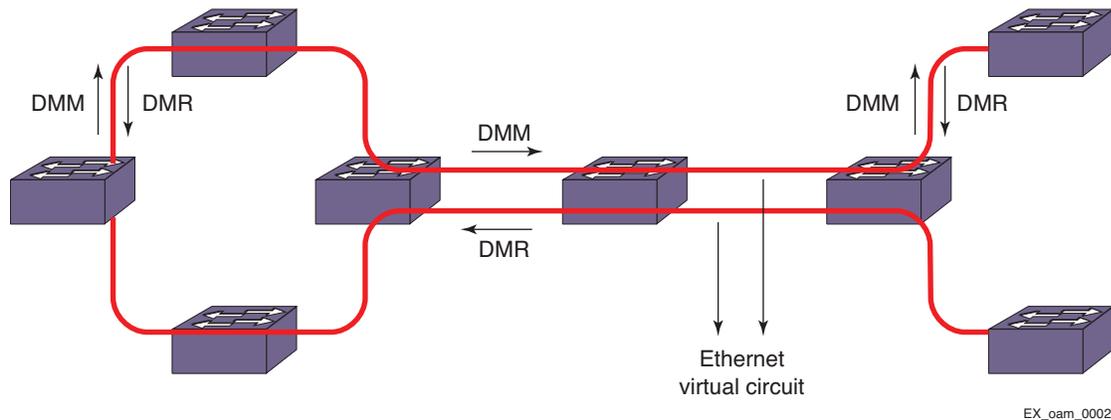
RxTimeStampt—Timestamp at the time of receiving a frame with ETH-DM request information

TxTimeStampt—Timestamp at the time of transmitting a frame with ETH-DM reply information

Here the frame delay is calculated by the peer that receives the DMR as follows:

$$\text{Frame Delay} = (\text{RxTimeStampt} - \text{TxFTimeStampt}) - (\text{TxFTimeStampt} - \text{RxTimeStamptf})$$

Figure 44 describes the DMM and DMR message flows between two end points.

Figure 44: Two-Way Frame Delay and Frame Delay Variance Measurement

The PDUs used to measure frame delay and frame delay variation are the DMM and the DMR PDUs where DMM is initiated from a node as a request to its peer and DMR is the reply from the peer.

**NOTE**

When Summit X460, E4G-200 series switches are running EXOS 15.1 or later firmware, the down MEP are performed in the hardware when configured on a normal port and the down MEP are performed in the software when configured on a LAG port and Up MEP are performed in the software for all the ports. When E4G-200 series switch running EXOS 15.1 or later firmware, the measurement (time stamping) of frame delay and loss measurements are performed in the hardware. On all other ExtremeXOS-based platforms, time stamping is always performed in the software.

If you try to enable the transmission for a CFM segment whose configuration is not complete, the trigger is rejected and an error message similar to the following is given.

```
ERROR: CFM Configuration is not complete for segment "s1" to start transmission
```

**NOTE**

A CFM segment without a domain and an association is considered to be an incomplete segment.

Upon enabling the transmission from a CFM segment, the segment transmits DMM frames, one at each transmit-interval which is configured through the CLI. If the user enables on-demand transmission, the segment transmits "X" number of DMMs and moves back to the disabled state, where "X" is the number of frames specified by the user through the CLI.

For continuous transmission, the segment continues to transmit DMM frames until stopped by the user. This transmission continues even after reboot for both continuous and on-demand mode. For on-demand transmission, the segment, which was enabled to transmit "X" number of frames, and is still transmitting, starts transmitting again "X" number of frames after reboot, or MSM failover, or process restart. The old statistics are not preserved for both continuous and on-demand mode for all the above three scenarios.

Upon transmitting a DMM, the segment is expected to get a reply from the destination within the specified time. If a reply is received after that time, that reply will be considered as a delayed one.

If a reply is not received within the transmit-interval, that is, between two subsequent DMM transmissions, then that frame is considered as lost. Once the percentage of the sum of lost and delayed frames reaches the alarm threshold, an alarm is generated and the segment is moved to the alarming state. This state is maintained until the percentage of valid replies reaches the clear threshold. These alarm and clear states are maintained for a specified window, which holds a set of recent frames and their corresponding delays.

Various times are recorded at the segment level during the transmission of DMM frames.

- Start time—Time at which the segment started the current transmission.
- Min delay time—Time at which the minimum delay occurred in the current transmission window.
- Max delay time—Time at which the maximum delay occurred in the current transmission window.
- Alarm time—The recent alarm time, if any, during the current transmission.

The mean delay and delay variance for the current window is also measured whenever the user polls the segment statistics.

Frame-Loss Measurement

Frame-loss is measured by sending and receiving frames with frame-loss information between peer maintenance end points (MEPs).

Frame-loss ratio is defined as a percentage of the number of service frames not delivered divided by the total number of service frames during a defined time interval, where the number of service frames not delivered is the difference between the number of service frames arriving at the ingress Ethernet flow point and the number of service frames delivered at the egress Ethernet flow point in a point-to-point Ethernet connection (see [Figure 45](#)).

Figure 45: Frame-Loss Ratio Formula

$$\text{Frame Loss Ratio} = \left(\frac{\text{Svc Frames at Ingress} - \text{Svc Frames at Egress}}{\text{Svc Frames at Ingress}} \right)$$

To support frame-loss measurement, a MEP requires the following configuration information:

- Maintenance domain (MD) level—MD level at which the MEP exists
- Frame-loss measurement transmission period—time interval when frame-loss measurement frames are sent
- Priority—identifies the priority of the frames with frame-loss measurement information (configurable per operation)
- Drop eligibility—frames with frame-loss measurement information are always marked as drop ineligible (not necessarily configured)

A maintenance intermediate point (MIP) is transparent to frames with frame-loss measurement information. Therefore MIPs do not require any information to support frame-loss measurement functionality.

There are two Frame-loss measurement methods:

- [Dual-Ended Frame-Loss Measurement on page 423](#)
- [Single-Ended Frame-Loss Measurements on page 424](#)

Dual-Ended Frame-Loss Measurement



NOTE

ExtremeXOS doesn't support dual-ended frame-loss measurement.

Dual-ended frame-loss measurement is a form of proactive OAM for performance monitoring and is useful for fault management. MEPs send periodic dual-ended frames with frame-loss measurement information to peer MEPs in a point-to-point MD. Each MEP terminates the dual-ended frames with frame-loss measurement information and makes the near-end and far-end loss measurements. Near-end frame loss refers to frame loss associated with ingress data frames, while far-end frame loss refers to frame loss associated with egress data frames. This function is used for performance monitoring at the same priority level as used for CCM.

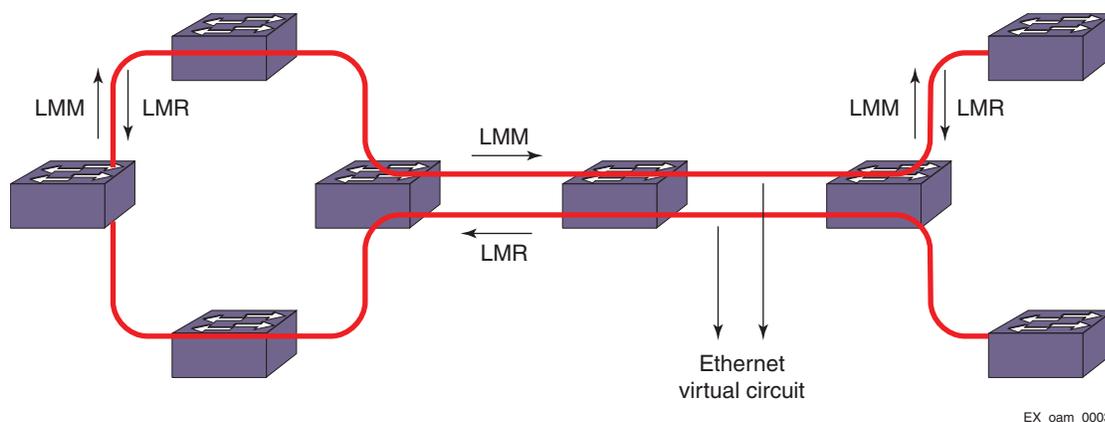
The protocol data unit (PDU) for dual-ended frame-loss measurement information is Continuity Check Message (CCM).

Single-Ended Frame-Loss Measurements

Single-ended frame-loss measurement facilitates on-demand OAM. MEPs carry out frame-loss measurements by sending frames to peer MEPs with frame-loss measurement request information and receiving frames with frame-loss measurement reply information.

The PDU for single-ended frame-loss measurement *requests* is Loss Measurement Message (LMM). The PDU for single-ended frame-loss measurement *reply* is Loss Measurement Reply (LMR). [Figure 46](#) shows the transmission of LMM and LMR for frame-loss measurement.

Figure 46: Two-Way Frame-Loss Measurement



A MEP maintains two local counters for each peer MEP it's monitoring for frame-loss:

- TxFCI—in-profile data frames *transmitted* to the peer MEP
- RxFCI—in-profile data frames *received* from the peer MEP

For an on-demand loss measurement, a MEP periodically transmits LMM frames with TxFCf (value of the local TxFCI counter at the time of LMM frame transmission). Upon receiving a valid LMM frame, a MEP sends an LMR frame to the requesting MEP. (Valid LMM frames have a valid MD level and a destination MAC address equal to the receiving MEP's MAC address.)

An LMR frame contains the following values:

- TxFCf—TxFCf value copied from the LMM frame
- RxFCf—RxFCI value when the LMM frame was received
- TxFCb—TxFCI value when the LMR frame was transmitted

Upon receiving an LMR frame, a MEP uses the following values to make near-end and far-end loss measurements:

- Received LMR frame's TxFCf, RxFCf, and TxFCb values; and local counter RxFCI value at the time this LMR frame was received. These values are represented as TxFCf[tc], RxFCf[tc], TxFCb[tc], and RxFCI[tc]; where tc is the time the current reply frame was received.

- Previous LMR frame's TxFCf, RxFCf, and TxFCb values; and local counter RxFCI value at the time the previous LMR frame was received. These values are represented as TxFCf[tp], RxFCf[tp], TxFCb[tp], and RxFCI[tp]; where tp is the time the previous reply frame. was received

$$\text{Far-End Frame Loss} = (\text{TxFCf}[\text{tc}] - \text{TxFCf}[\text{tp}]) - (\text{RxFCf}[\text{tc}] - \text{RxFCf}[\text{tp}])$$

$$\text{Near-End Frame Loss} = (\text{TxFCb}[\text{tc}] - \text{TxFCb}[\text{tp}]) - (\text{RxFCI}[\text{tc}] - \text{RxFCI}[\text{tp}])$$

Availability Time and Severly Errored Seconds (SES)

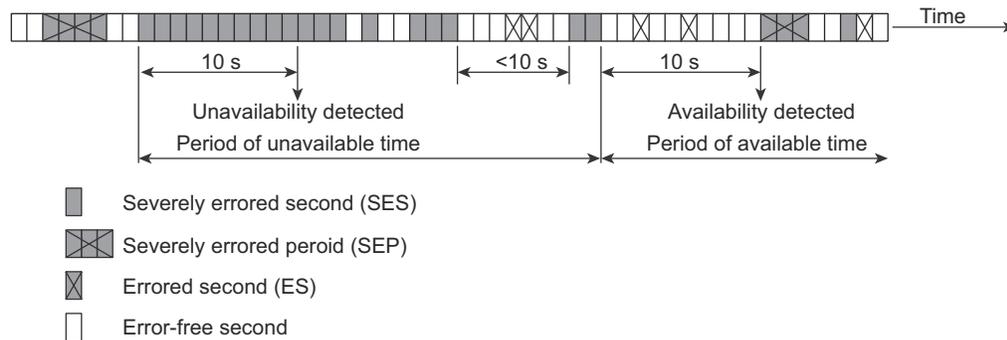
Frame loss is measured by sending and receiving frames with frame-loss information between peer MEPs. Each MEP performs frame-loss measurements which contribute to unavailable time. Since a bidirectional service is defined as unavailable if either of the two directions is declared unavailable, frame-loss measurement must facilitate each MEP to perform near-end and far-end frame loss measurements.

Near-end frame loss refers to frame loss associated with ingress data frames, while far-end frame loss refers to frame loss associated with egress data frames. Both near-end and far-end frame loss measurements contribute to near-end severely errored seconds (near-end SES) and far-end severely errored seconds (far-end SES) respectively, which together contribute to unavailable time.

A period of unavailable time begins at the onset of x consecutive Severly Errored Seconds (SES) events. These x seconds are part of unavailable time. A new period of available time begins at the onset of x consecutive non-SES events. These x seconds are part of available time.

A SES is declared when, during one measurement period, the number of frames lost exceeds a threshold. ExtremeXOS logs the start and end time of the unavailable periods (see [Figure 47](#) from *ITU-T G.7710*).

Figure 47: SES



Configuring a CFM Segment

Use the following commands to configure a CFM segment. Some of these commands are optional and, if not configured, the default values are used.

Table 49 lists the default values for delay measurement for a CFM segment:

Table 49: Default Values for Delay Measurement for a CFM Segment

Configuration	Default Values
Transmit interval	10 seconds
Window	60 frames
Timeout	50 msecs
Alarm threshold	10%
Clear threshold	95%
Dot1p priority	6

Table 50 lists the default values for loss measurement for a CFM segment:

Table 50: Default Values for Loss Measurement for a CFM Segment

Configuration	Default Values
LMM Transmit interval	90 seconds
Dot1p priority	6
Window	1200 frames
SES threshold	0.01
Consecutive available count	4



NOTE

The statistics for a particular transmission are preserved until the user triggers the transmission once again or if “clear counters cfm segment” is triggered from the CLI.

To create a CFM segment, use the following command:

```
create cfm segment <segment_name> destination <mac_addr> {copy <segment_name_to_copy>}
```

To delete a CFM segment, use the following command:

```
delete cfm segment [<segment_name | all]
```

To add a CFM domain to a CFM segment, use the following command:

```
configure cfm segment <segment_name> add domain <domain_name> association <association_name>
```

To delete a CFM domain from a CFM segment, use the following command:

```
configure cfm segment <segment_name> delete domain association
```

To configure the transmission interval between two consecutive DMM or two consecutive LMM frames, use the following command:

```
configure cfm segment <segment_name> {frame-delay | frame-loss} transmit-interval <interval>
```

The same transmit-interval is used for both delay and loss measurements. Separate values for delay and loss measurements can be given by specifying the following command:

```
configure cfm segment frame-delay/frame-loss transmit interval <interval>
```

To configure the dot1p priority of a DMM frame, use the following command:

```
configure cfm segment <segment_name> frame-delay dot1p <dot1p_priority>
```

To configure the dot1p priority of a LMM frame, use the following command:

```
configure cfm segment <segment_name> frame-loss dot1p <dot1p_priority>
```

To configure the dot1p priority of the CFM segment, use the following command:

```
configure cfm segment <segment_name> dot1p <dot1p_priority>
```

The same priority is used for both delay and loss measurements. Separate values of priority for delay and loss measurements can be obtained by specifying the following commands:

```
configure cfm segment <segment_name> frame-delay dot1p <dot1p_priority>
configure cfm segment <segment_name> frame-loss dot1p <dot1p_priority>
```

To configure the alarm and clear threshold value for CFM segment, use the following command:

```
configure cfm segment <segment_name> [alarm-threshold | clear-threshold] <value>
```

To configure the window size to be used for calculating the threshold values, use the following command:

```
configure cfm segment <segment_name> window <size>
```

The same window size is used for both delay and loss measurements. Separate values of window size for delay and loss measurements can be obtained by specifying the following commands:

```
configure cfm segment <segment_name> frame-loss window <window_size>
configure cfm segment <segment_name> frame-delay window <window_size>
```

To configure the window size of a DMM frame to be used for calculating the threshold values, use the following command:

```
configure cfm segment <segment_name> frame-delay window <window_size>
```

To configure the window size of a LMM frame to be used for calculating the threshold values, use the following command:

```
configure cfm segment <segment_name> frame-loss window <window_size>
```

To trigger DMM frames at the specified transmit interval, use the following command:

```
enable cfm segment frame-delay measurement <segment_name> [continuous | count <value>]
```

To disable the transmission of the DMM frames for a particular CFM segment, use the following command:

```
disable cfm segment frame-delay measurement <segment_name>
```

To show the configuration and status of a specific CFM segment, use the following command:

```
show cfm segment {<segment_name>}
```

To show the configuration and status of a specific CFM segment doing delay measurement, use the following command:

```
show cfm segment frame-delay {<segment_name>}}
```

To show the configuration and status of a specific CFM segment doing loss measurement, use the following command:

```
show cfm segment frame-loss {<segment_name>}}
```

To display the frame delay statistics for the CFM segment, use the following command:

```
show cfm segment frame-delay statistics {<segment-name>}
```

To configure the timeout value for a CFM segment, use the following command:

```
configure cfm segment <segment_name> timeout <msec>
```

To add or delete the local MEP for a given CFM segment, use the following command:

```
configure cfm segment <segment_name> frame-loss [add|delete] mep <mep_id>
```

To set the percentage of frames lost in a measurement period so that it will be marked as SES (severely errored second), use the following command:

```
configure cfm segment <segment_name> frame-loss ses-threshold <percent>
```

To set the number of consecutive measurements used to determine the availability status of a CFM segment, use the following command:

```
configure cfm segment <segment_name> frame-loss consecutive <frames>
```

To start the transmission of LMM frames for the set transmit interval, use the following command:

```
enable cfm segment frame-loss measurement <segment_name> mep <mep_id> [continuous | count <frames>]
```



NOTE

For the above command, if the segment is not completely configured, frames are not transmitted and an error occurs.

To stop the transmission of the LMM frames for a particular CFM segment, use the following command:

```
disable cfm segment frame-loss measurement <segment_name> mep <mep_id>
```

To display the frame loss or frame delay statistics for the CFM segment, use the following commands:

```
show cfm segment {{{<segment_name>} | {frame-delay {<segment_name>}} | {frame-loss {<segment_name> {mep <mep_id>}}}}
```

Clearing CFM Information

To clear cfm segment counters, use the following commands:

```
clear counters cfm segment <segment_name>
clear counters cfm segment all
```

To clear cfm segment counters specific to DMM, use the following commands

```
clear counters cfm segment <segment_name> frame-delay
```

To clear cfm segment counters specific to LMM, use the following commands:

```
clear counters cfm segment <segment_name> frame-loss  
clear counters cfm segment <segment_name> frame-loss mep <mep_id>
```

EFM OAM—Unidirectional Link Fault Management

This section describes the following topics:

- [Summit X450a Series Switches Only on page 430](#)
- [Unidirectional Link Fault Management on page 430](#)
- [Configuring Unidirectional Link Fault Management on page 432](#)

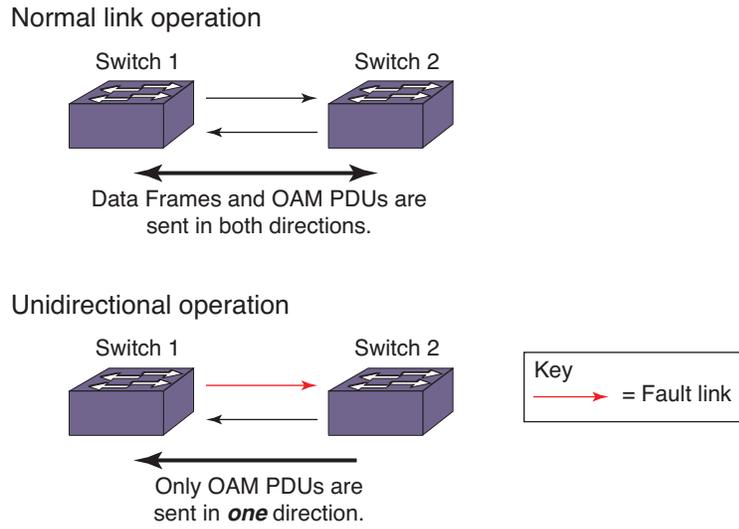
Summit X450a Series Switches Only

IEEE 802.3ah, the Ethernet in the First Mile (EFM) standard, includes mechanisms for network Operation, Administration and Maintenance (OAM) to facilitate metro Ethernet network operation and troubleshooting to match traditional carrier network technologies. This section covers that portion of EFM that deals with the unidirectional link fault indication on a 1G link that has the capability to transmit and receive independently.

In carrier networks, Ethernet is usually deployed with an optical link. Historically on Ethernet, when one direction of communication fails on a link, the other direction of the link is taken down. This behavior eliminates the possibility of one-way transmissions, so that higher layer protocols do not have to deal with that error scenario.

Unidirectional Link Fault Management

With EFM OAM, however, certain physical layers can support a limited unidirectional capability. The ability to operate a link in a unidirectional mode for diagnostic purposes supports the maintenance objective of failure detection and notification. Unidirectional OAM operation is not supported on some legacy links but is supported on newer links such as 100BASE-X PCS, 1000BASE-X PCS, and 10GbE RS. On technologies that support the feature, OAM PDUs can be transmitted across unidirectional links to indicate fault information. To the higher layers, the link is still failed in both directions, but to the OAM layer, some communication capabilities exist. The distinction between a unidirectional link and a normal link is shown in [Figure 48](#).

Figure 48: Normal Link and Unidirectional Operation

EX_oam_0003

You can enable unidirectional link fault detection and notification on individual ports with CLI commands. This allows appropriate register settings to transmit OAM PDUs even on a link that has a slowly deteriorating quality receive path or no receive path at all. Then, when a link is not receiving a signal from its peer at the physical layer (for example, if the peer's laser is malfunctioning), the local entity can set a flag in an OAM PDU to let the peer know that its transmit path is inoperable.

The operation of OAM on an Ethernet interface does not adversely affect data traffic because OAM is a slow protocol with very limited bandwidth potential, and it is not required for normal link operation. By utilizing the slow protocol MAC address, OAM frames are intercepted by the MAC sub layer and cannot propagate across multiple hops in an Ethernet network. This implementation assures that OAM PDUs affect only the operation of the OAM protocol itself and not user data traffic.

The IEEE 802.3ah standard defines fault notifications based on one-second timers. But by sending triggered OAM PDUs on detecting link down/local fault rather than waiting to send on periodic PDUs, failure detection is less than 1 second can be achieved thereby accelerating fault recovery and network restoration.

EFM OAM uses standard length Ethernet frames within the normal frame length of 64 to 1518 bytes as PDUs for their operation. [Table 51](#) describes the fields of OAM PDUs.

Table 51: OAM PDU Fields

Field	Octets	Description	Value
Destination Address	6	Slow protocol multicast address	01:80:C2:00:00:02
Source Address	6	Port's individual MAC address	Switch MAC
Length/Type	2	Slow protocol type	0x8809
Subtype	1	Identifies specific slow protocol	0x03
Flags	2	Contains status bits	see Figure 48
Code	1	Identifies OAM PDU type	0x00 (Information TLV)
Data/Pad	42-1496	OAM PDU data	0x00 (END of TLV)
FCS	4	Frame check sequence	

Configuring Unidirectional Link Fault Management

The following are requirements to configure unidirectional link fault management on a port of a Summit X450a series switch:

- The switch link must have the capability to independently transmit and receive.
- Autonegotiation must be turned off.
- The link should be operating in full duplex mode.
- ELSM must not be enabled.

To configure unidirectional link fault management on a port or ports, use the following command:

```
enable ethernet oam ports [<port_list> | all] link-fault-management
```

To clear the counters on a configured port, use the following command:

```
clear ethernet oam {ports [<port_list>]} counters
```

To unconfigure unidirectional link fault management, use the following command:

```
disable ethernet oam ports [<port_list> | all] link-fault-management
```

To display the Ethernet OAM settings, use the following command:

```
show ethernet oam {ports [<port_list>]} {detail}
```

When configured, the following behavior on the port is observed:

- A log indicates that traffic on the port is blocked.
- All received traffic on that port is blocked except for Ethernet OAM PDUs.
- To higher layers, a failure is reported as a link down but OAM can use the link to send OAM traffic.

Bidirectional Forwarding Detection (BFD)

This section describes the following topics:

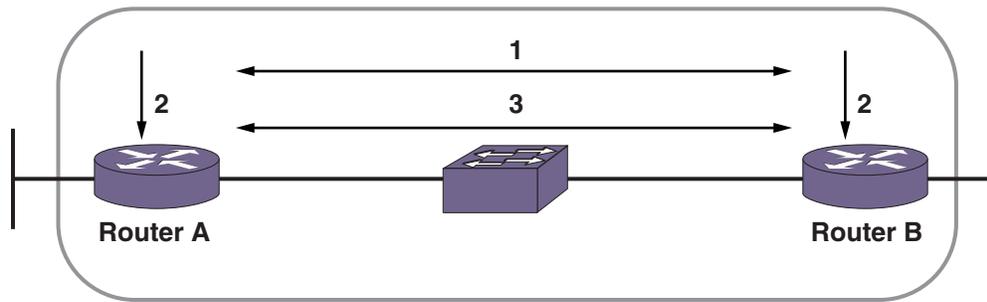
- [Overview on page 432](#)
- [Limitations on page 435](#)
- [Configuring BFD on page 435](#)
- [Displaying BFD Information on page 435](#)
- [Clearing BFD Information on page 436](#)

Overview

Bidirectional Forwarding Detection (BFD) is a hello protocol that provides the rapid detection of failures in the path and informs the clients (routing protocols) to initiate the route convergence. It is independent of media, routing protocols and data protocols. BFD helps in the separation of forwarding plane connectivity and control plane connectivity.

Different routing protocol hello mechanisms operate in variable rates of detection, but BFD detects the forwarding path failures at a uniform rate thus allowing for easier network profiling and planning, and consistent and predictable re-convergence time.

Figure 49 shows a BFD topology.

Figure 49: BFD Topology

1. Routing protocol (BFD client) discovers neighbor
2. Routing protocol informs BFD to create session with neighbor
3. BFD establishes session with neighbor

EX_bfd_0001

The routing protocols first learn the neighbor and make entries in the forwarding table. Then protocols can register the neighbor address with BFD and ask to monitor the status of the path. BFD establishes the session with a remote BFD and monitors the path status.

You can configure detection multipliers and TX and RX intervals on a directly connected interface (VLAN).

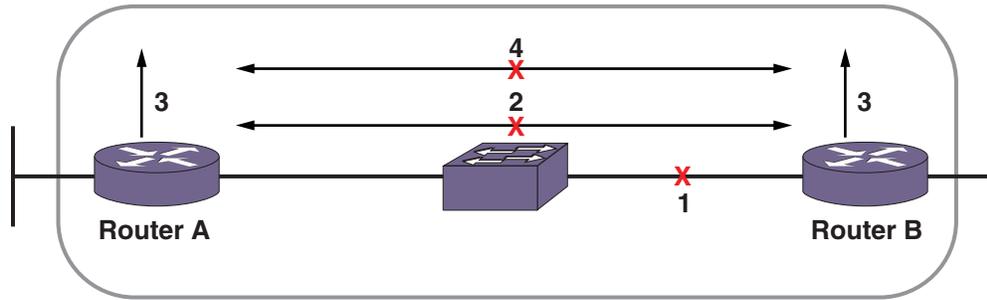
- The detection multiplier signifies the number of BFD packets the BFD server waits for after which a timeout is declared.
- The receive interval is the interval at which the BFD server is ready to receive packets.
- The transmit interval is the interval at which the BFD server is ready to transmit packets.

For example, when two nodes, A and B, initiate a BFD session between them, a negotiation about the receive and transmit intervals occurs. The receive interval of node A is calculated as the maximum of the configured receive interval of node A and the configured transmit interval of node B. The same applies to node B.

If multiple clients ask for the same neighbor on the same interface, then a single BFD session is established between the peers.

[Figure 50](#) shows the behavior when a failure occurs.

Figure 50: BFD Failure Detection



1. Link fails
2. BFD detects failure
3. BFD reports failure to routing protocol
4. Routing protocol takes necessary action for failure

EX_bfd_0002

BFD detects the failure first and then informs the registered clients about the neighbors.

BFD operates in an asynchronous mode in which systems periodically send BFD control packets to one another. If a number of those packets in a row are not received by the other system, the session is declared to be down.

Simple password authentication can be included in the control packet to avoid spoofing.

This feature is available on all platforms.

**NOTE**

BFD can be used to protect IPv4 static routes and MPLS interfaces. For more information, see [“Configuring Static Routes”](#) on page 1218 or refer to [“Managing the MPLS BFD Client”](#) on page 1167.

Limitations

The following limitations apply to BFD in this release:

- Direct connection (single hop) networks only are supported.
- IPv4 only is supported.
- MPLS and static routes act as BFD clients.
- Hitless failover is supported.
- The echo function is not supported.

Configuring BFD

To enable or disable BFD, use the following command:

```
[enable | disable] bfd vlan <vlan_name>
```

To configure the detection multipliers and TX and RX intervals use the following command:

```
configure bfd vlan <vlan_name> [{detection-multiplier <multiplier>} {receive-interval <rx_interval>} {transmit-interval <tx_interval>}]
```

To specify either authentication using a simple password or no authentication, use the following command:

```
configure bfd vlan <vlan_name> authentication [none | simple-password {encrypted} <password>]]
```

To unconfigure BFD, use the following command:

```
unconfigure bfd vlan <vlan_name>
```

Displaying BFD Information

The following commands display information regarding BFD configuration and process.

To display information on BFD sessions, use the following command:

```
show bfd
```

To display information on BFD global counters, use the following command:

```
show bfd counters
```

To display information on BFD session counters, use the following command:

```
show bfd session counters vr all
```

To display the configuration of a specific interface or those specific counters, use the following command:

```
show bfd vlan {<vlan_name>}
```

To display the counters of a specific interface, use the following command:

```
show bfd vlan {<vlan_name>} counters
```

To display the session status of a particular client, use the following command:

```
show bfd session client [static | mpls] {vr <vr_name> | all}
```

To display the session status information for all VRs, use the following command:

```
show bfd session vr all
```

To display session status information in detail for all VRs, use the following command:

```
show bfd session detail vr all
```

Clearing BFD Information

To clear global, session, or interface counters, use the following command:

```
clear counters bfd {session | interface}
```

10 PoE

CHAPTER

This chapter includes the following sections:

- [Overview on page 437](#)
- [Extreme Networks PoE Devices on page 438](#)
- [Summary of PoE Features on page 439](#)
- [Power Checking for PoE Module on page 439](#)
- [Power Delivery on page 440](#)
- [Configuring PoE on page 444](#)
- [Displaying PoE Settings and Statistics on page 451](#)

Overview

Power over Ethernet (PoE) is an effective method of supplying 48 VDC power to certain types of powered devices (PDs) through Category 5 or Category 3 twisted pair Ethernet cables. PDs include wireless access points, IP telephones, laptop computers, web cameras, and other devices. With PoE, a single Ethernet cable supplies power and the data connection, reducing costs associated with separate power cabling and supply.

The system supports hitless failover for PoE in a system with two Management Switch Fabric Modules (MSMs). Hitless failover means that if the primary MSM fails over to the backup MSM, all port currently powered will maintain power after the failover and all the power configurations remain active.

Similar failover support is available for a SummitStack. In a SummitStack, power is maintained across a failover on all PoE ports of non-primary nodes but is lost on all PoE ports of the failed primary node. Each Summit switch has its own PSU and the power budget for each Summit switch is determined by the internal/external PSUs connected to that Summit switch.

PoE+ supports higher power levels as defined by the IEEE 802.3at standard.

Extreme Networks PoE Devices

Following is a list of the Extreme Networks devices that support PoE and the minimum required software:

- 8500-G48T-e module (with daughter card) for the BlackDiamond 8800 series switch—ExtremeXOS 12.3 and later
- G48Tc module (with daughter card) for the BlackDiamond 8800 series switch—ExtremeXOS 12.1 and later
- G48Te2 module (with daughter card) for the BlackDiamond 8800 series switch—ExtremeXOS 12.1 and later
- 8900-G48T-xl module (with daughter card) for the BlackDiamond 8800 series switch—ExtremeXOS 12.4 and later
- Summit X150-24p switch—ExtremeXOS 12.1 and later
- Summit X250e-24p switch—ExtremeXOS 12.0 and later
- Summit X250e-48p switch—ExtremeXOS 12.0 and later
- Summit X450e-24p switch—ExtremeXOS 11.5 and later
- Summit X450e-48p switch—ExtremeXOS 11.6 and later

Following is a list of the Extreme Networks devices that support PoE+ and the minimum required software:

- Summit X440-24p switch—ExtremeXOS 15.1 and later
- Summit X440-48p switch—ExtremeXOS 15.1.2 and later
- Summit X460-24p switch—ExtremeXOS 12.5 and later
- Summit X460-48p switch—ExtremeXOS 12.5 and later



NOTE

PoE capability for the G48Tc and G48Te2 modules are available only with the addition of an optional PoE Daughter Module. See [“Adding an S-PoE Daughter Card to an Existing Configuration”](#) on page 449 for more information.

Summit X250e-48p and Summit X450e-48p switches offer an optional external power supply chassis (EPS-C) that accepts up to three power modules (EPS-600LS). [Table 52](#) describes the EPS-C/EPS-600LS options for X250e-48p and X450e-48p switches.

Table 52: EPS-C/EPS-600LS Options for Summit X250e-48p and X450e-48p Switches

Number of EPS-600LS Module	Summit X250e-48p and X450e-48p PoE Capability
0	Internal PSU 405 watt PoE power
1	Redundant 405 watt PoE power
2	Full 810 watt PoE power. No PoE redundancy
3	Full 810 watt PoE power. 2:1 power module redundancy

When using the EPS-C with 0 or 1 EPS-600LS modules, 405 W of PoE power is available for the Summit X250e-48p and 450e-48p PDs, for instance, 16.8 W to 24 ports, 8.4 W to 48 ports or any combination where the total PoE power does not exceed the 405 watt PSU capacity.

If the total system demands exceed the available power on the Summit X250e-48p or X450e-48p switch, you can specify the port priorities and port disconnect precedence.

When using the EPS-C with 2 or 3 EPS-600LS modules, 810 W of PoE power is available, for instance, 16.8 W to 48 ports.

When disconnecting an EPS-C from a Summit X250e-48p or X450e-48p switch, you should turn off the EPS-600LS one module at a time. This allows an uninterrupted PoE transition from full power to redundant half power to internal power. Suddenly removing an EPS-C with 2 or 3 EPS-600LS modules providing power will cause an interruption of PoE power to the PDs.

**NOTE**

Refer to the Summit Family Switches Hardware Installation Guide for complete information on power availability using the Summit X250e-48p and X450e-48p switches in conjunction with the EPS-600 PSU.

Summary of PoE Features

The ExtremeXOS implementation of PoE supports the following features:

- Configuration and control of the power distribution for PoE at the system, slot, and port levels
- Real-time discovery and classification of IEEE 802.3af-compliant PDs and many legacy devices
- Support for IEEE 802.3at-compliant PDs on PoE+ devices
- Monitor and control of port PoE fault conditions including exceeding configured class limits and power limits and short-circuit detection
- Support for configuring and monitoring PoE status at the system, slot, and port levels
- Management of an over-subscribed power budget
- Port LED control for indicating the link state
- Support for hitless failover in a chassis with two MSMs

For detailed information on using the PoE commands to configure, manage, and display PoE settings, refer to the *ExtremeXOS Command Reference Guide*.

Power Checking for PoE Module

PoE modules require more power than other I/O modules. When a chassis containing a PoE module is booted or a new PoE module is inserted, the power drain is calculated. Before the PoE module is powered up, the chassis calculates the power budget and powers up the PoE module only if there is enough power. The chassis powers up as many I/O modules as possible with lower-numbered slots having priority.

**NOTE**

If your chassis has an inline power module and there is not enough power to supply the configured inline power for the slot, that slot will not power on; the slot will not function in data-only mode without enough power for inline power.

If a PoE module is inserted into a chassis, the chassis calculates the power budget and powers up the PoE module only if there is enough power. Installed modules are not affected. However, if you reboot the chassis, power checking proceeds as described in the previous paragraph. If there is now enough power, I/O modules that were not powered up previously are powered up.

If you lose power or the overall available power decreases, the system *removes* power to the I/O modules beginning with the highest numbered slots until enough power is available. Inline power reserved for a slot that is not used cannot be used by other PoE slots (inline power is not shared among PoE modules).

Before you install your PoE module, consult your sales team to determine the required power budget.

Power Delivery

This section describes how the system provides power to the PDs.

Enabling PoE to the Switch

PoE is enabled by default. Refer to the [Configuring PoE](#) section for details about changing the configuration.

Power Reserve Budget

Summit X250e-48p, X450e-24p, X450e-48p Switches Only

For Summit X250e-48p, X450e-24p, and X450e-48p switches, the power budget is set by the capability of the power supplies connected. For each of these Summit switches, the internal PSU is capable of 405 W of PoE power.

For Summit X250e-48p and X450e-48p switches, the PoE capability is increased according to the external PSUs installed. (Refer to the *Summit Family Switches Hardware Installation Guide* for complete information on power availability with this optional unit.)

Summit X460-24p and X460-48p Switches Only

Summit X460-24p and X460-48p switches have two removable internal PSUs, each capable of delivering 380 W of power. When two PSUs are present, the total power budget is 760 W and PSU load-sharing is in effect. If one PSU fails or is removed then the power budget will drop to 380 W and port priority will be used to determine which ports remain powered up if usage was more than 380 W before the event.

Summit X440-24p and X440-48p Switches Only

The Summit X440-24p switches have one internal PSU capable of delivering 380 W of power.

Summit X440-8p Switches Only

The Summit X440-8p switches have one internal PSU capable of delivering 170 W of power.

Modular Switches Only

On modular PoE switches, the power budget is provided on a per slot basis, not switchwide. You reserve power for each slot, or PoE module. Power reserved for a specific PoE module cannot be used by any other slot regardless of how much power is actually consumed on the specified slot. The default power budget reserved for each PoE module is 50 W. The minimum power you can assign to a slot is 37 W, or 0 W if the slot is disabled. The maximum possible for each slot is 768 W.



NOTE

Extreme Networks recommends that, when using a modular switch, you fully populate a single PoE module with PDs until the power usage is just below the usage threshold, instead of spacing PDs evenly across PoE modules.

If you disable a slot with a PoE module, the reserved power budget remains with that slot until you unconfigure or reconfigure the power budget. Also, you can reconfigure the reserved power budget for a PoE module without disabling the device first; you can reconfigure dynamically. These settings are preserved across reboots and other power-cycling conditions.

The total of all reserved slot power budgets cannot be larger than the total available power to the switch. If the base module power requirements plus the reserved PoE power for all modules exceeds the unallocated power in the system, the lowest numbered slots have priority in getting power and one or more modules in higher-numbered slots will be powered down.



NOTE

On modular switches, PoE modules are not powered-up at all, even in data-only mode, if the reserved PoE power cannot be allocated to that slot.

Guard Band

To reduce the chances of ports fluctuating between powered and non-powered states, newly inserted PDs are not powered when the actual delivered power for the module or switch is within a preset value below the configured inline power budget for that slot or switch. This band is called the guard band and the value used is 19 W for modular switches and Summit X250e-48p, X450e-24p, and X450e-48p switches and 20 W for Summit X440-24p, X460-24p, X460-48p, X440-8p, and X440-48p switches. However, actual aggregate power can be delivered up to the configured inline power budget for the slot or switch (for example, when delivered power from ports increases or when the configured inline power budget for the slot is reduced).

PD Disconnect Precedence

Summit X250e-48p, X440-24p, X450e-48p, X460-24p, X460-48p, X440-8p, X440-48p and Modular PoE Switches Only

After a PD is discovered and powered on a Summit X250e-48p, X440-24p, X450e-48p, X460-24p, X460-48p or a modular PoE switch, the actual power drain is continuously measured. If the usage for power by PDs is within the guard band, the system begins denying power to PDs.

To supply power to all PDs on a modular switch, you can reconfigure the reserved power budget for the switch or slot, so that enough power is available to power all PDs. You reconfigure the reserved power budget dynamically; you do not have to disable the device to reconfigure the power budget.

You configure the switch to handle a request for power that exceeds the power budget situation in one of two ways, called the disconnect precedence:

- Disconnect PDs according to the configured PoE port priority for each PD.
- Deny power to the next PD requesting power, regardless of that port's PoE priority.

On modular switches, this is a switchwide configuration that applies to each slot; you cannot configure this disconnect precedence per slot.

The default value is deny-port. So, if you do not change the default value and the switch's or slot's power is exceeded, the next PD requesting power is not connected (even if that port has a higher configured PoE port priority than those ports already receiving power). When you configure the deny-port value, the switch disregards the configured PoE port priority and port numbering.

When the switch is configured for lowest-priority mode, PDs are denied power based on the individual port's configured PoE priority. If the next PD requesting power is of a higher configured PoE priority than an already powered port, the lower-priority port is disconnected and the higher-priority port is powered.

PoE Port Priority

Summit X250e-48p, X440-24p, X450e-48p, X460-24p, X460-48p Switches, and Modular PoE Switches only. On Summit X250e-48p, X450e-48p, X460-24p, X460-48p switches, and modular PoE switches, you can configure the PoE priority for each port as low, high, or critical; the default value is low. If you configure the disconnect precedence of the switch as lowest priority, the switch disconnects those PDs with lower PoE port priorities when the reserved switch or slot power budget is exceeded; the system continues supplying power to PDs with higher PoE port priorities.

If several PDs have the same configured PoE port priority, the priority is determined by the port number. The highest port number has the lowest PoE priority.

The switch withdraws power (or disconnects) those ports with the *highest* port number (s). That is, the highest port number is the lowest PoE priority.

Port Disconnect or Fault

On modular PoE switches, when a port is disconnected, the power is removed from that port and can be used *only* by ports on the same slot. The power from the disconnected port is not redistributed to any other slot.

On all PoE devices, when a port enters a fault state because of a class violation or if you set the operator limit lower than the amount requested by the PD, the system removes power from that port. The power removed is, again, available only to other ports on the same slot or stand-alone switch; it cannot be redistributed to other slots on modular switches. The port stays in the fault state until you disable that port, or disconnect the attached PD, or reconfigure the operator limit to be high enough to satisfy the PD requirements.

When a port is disconnected or otherwise moves into a fault state, SNMP generates an event (after you configure SNMP and a log message is created).

Port Power Cycling

You can set ports to experience a power-down, discover, power-up cycle.

On the Summit X250e-48p, X440-24p, X450e-48p, X460-24p, X460-48p, and modular PoE switches, this power-cycling occurs without returning the power to the slot's reserved power budget. This function allows you to reset PDs without losing their claim to the reserved power budget.

Ports are immediately depowered and repowered, maintaining current power allocations on modular switches.

PoE Usage Threshold

The system generates an SNMP event when any slot or stand-alone switch has consumed a specified percentage of that slot's reserved power budget or of the entire power for the stand-alone switch. The default value is 70%; you can configure this threshold to generate events from 1% to 99% consumption of the reserved power budget. You can also configure the system to log an Event Management System (EMS) message when the usage threshold is crossed (refer to [Chapter 11, "Status Monitoring and Statistics,"](#) for more information on EMS). On modular switches, this threshold percentage is set to be the same for each PoE slot; you cannot configure it differently for each PoE module.

On modular switches, although the threshold percentage of measured to budgeted power applies to all PoE modules, the threshold measurement applies only to the percentage *per slot* of measured power to budgeted power use; it does not apply to the amount of power used switchwide.

Legacy Devices

ExtremeXOS software allows the use of non-standard PDs with the switch. These are PDs that do not comply with the IEEE 802.3af standard.

The system detects non-standard PDs using a capacitance measurement. You must enable the switch to detect legacy devices; the default value is disabled. You configure the detection of legacy PoE devices per slot.

Detecting a PD through capacitance is used *only* if the following two conditions are *both* met:

- Legacy PD detection is enabled.
- The system unsuccessfully attempted to discover the PD using the standard resistance measurement method.

PoE Operator Limits

You set the power limit that a PD can draw on the specified ports. For PoE, the range is 3000 to 16800 mW, and the default value is 15400 mW. For PoE+, the range is 3000 to 30000 mW, and the default value is 30000 mW.

If the measured power for a specified port exceeds the port's operator limit, the power is withdrawn from that port and the port moves into a fault state.

If you attempt to set an operator-limit outside the accepted range, the system returns an error message.

Configuring PoE

PoE supports a full set of configuration and monitoring commands that allow you to configure, manage, and display PoE settings at the system, slot, and port level. Refer to the *ExtremeXOS Command Reference Guide* for complete information on using the CLI commands.

This section describes the following topics:

- [Enabling Inline Power on page 444](#)
- [Reserving Power on page 445](#)
- [Setting the Disconnect Precedence on page 446](#)
- [Configuring the Usage Threshold on page 447](#)
- [Configuring the Switch to Detect Legacy PDs on page 448](#)
- [Configuring the Operator Limit on page 448](#)
- [Configuring PoE Port Labels on page 449](#)
- [Power Cycling Connected PDs on page 449](#)
- [Adding an S-PoE Daughter Card to an Existing Configuration on page 449](#)

To enable inline power, or PoE, you must have a powered switch or chassis and module.



NOTE

On a module switch, if your chassis has an inline power module and there is not enough power to supply a slot, that slot will not power on; the slot will not function in data-only mode without enough power for inline power.

To configure inline power, or PoE, you must accomplish the following tasks:

- Enable inline power to the system, slot, and/or port.
- On modular switches and Summit X250e-48p and X450e-48p switches, reserve power to the switch or slot using a power budget.
- On modular switches and Summit X250e-48p, X440-24p, X450e-48p, X460-24p, and X460-28p switches, configure the disconnect precedence for the PDs in the case of excessive power demands.
- Configure the threshold for initiating system alarms on power usage.

Additionally, you can configure the switch to use legacy PDs, apply specified PoE limits to ports, apply labels to PoE ports, and configure the switch to allow you to reset a PD without losing its power allocation.

Enabling Inline Power

To enable inline power to the switch, slot, or port, use the following commands:

```
enable inline-power
enable inline-power slot <slot>
enable inline-power ports [all | <port_list>]
```

**NOTE**

On modular switches, if your chassis has an inline power module and there is not enough power to supply a slot, that slot will not power on; the slot will not function in data-only mode without enough power for inline power.

To disable inline power to the switch, slot (on modular switches), or port, use the following commands:

```
disable inline-power
disable inline-power slot <slot>
disable inline-power ports [all | <port_list>]
```

Disabling the inline power to a PD *immediately* removes power from the PD. Inline power is enabled by default.

To display the configuration for inline power, use the following command:

```
show inline-power
```

Reserving Power

Summit X250e-48p, X440-24p, X450e-48p, X460-24p, X460-48p Switches or a Slot on Modular PoE Switches Only.

On modular PoE switches, you reserve power for a given slot. The power reserved for a given slot cannot be used by any other PoE slots, even if the assigned power is not entirely used. To reallocate power among the slots, you must reconfigure each slot for the power budget you want; the power is not dynamically reallocated among PoE modules.

On Summit X250e-48p and X450e-48p switches (whether or not included in a SummitStack) which operate with the optional EPS-600 PSU, the power budget is set by the capability of the power supplies connected. The Summit X440-24p, X440-8p and X440-48p have one internal PSU capable of 380 W of PoE power. For Summit X450e-48p and X250e-48p switches, the internal PSU is capable of 405 W of PoE power. For Summit X460-24p and X460-48p switches, each internal PSU is capable of 380 W of PoE power. (Refer to the *Summit Family Switches Hardware Installation Guide* for complete information on power availability with this optional unit.)

You do not have to disable the PoE devices to reconfigure the power budgets.

On modular switches, the default power budget is 50 W per slot, and the maximum is 768 W. The minimum reserved power budget you can configure is 37 W for an enabled slot. If inline power on the slot is disabled, you can configure a power budget of 0.

**NOTE**

Extreme Networks recommends that you fully populate a single PoE module with PDs until the power usage is just below the usage threshold, instead of spacing PDs evenly across PoE modules.

To reset the power budget for a PoE module to the default value of 50 W, use the following command:

```
unconfigure inline-power budget slot <slot>
```

To display the reserved power budget for the PoE modules, use the following command:

```
show inline-power slot <slot>
```

To display the power budget for a Summit X450e-48p or X250e-48p switch, use the following command:

```
show inline-power
```

Setting the Disconnect Precedence

Summit X250e-48p, X440-24p, X450e-48p, X460-24p, X460-48p, or Modular PoE Switches Only



NOTE

The switch generates an SNMP event if a PD goes offline, and the port's state moves from Power to Searching. You must configure SNMP to generate this event.

When the actual power used by the PDs on a switch or slot exceeds the power budgeted for that switch or slot, the switch refuses power to PDs. There are two methods used by the switch to refuse power to PDs, and whichever method is in place applies to all PoE slots in the switch. This is called the disconnect precedence method, and you configure one method for the entire switch.

The available disconnect precedence methods are:

- Deny port
- Lowest priority

The default value is deny port. Using this method, the switch simply denies power to the next PD requesting power from the slot, regardless of that port's PoE priority or port number.

Using the lowest priority method of disconnect precedence, the switch disconnects the PDs connected to ports configured with lower PoE priorities. (Refer to "[Configuring the PoE Port Priority](#)" for information on port priorities.)

When several ports have the same PoE priority, the lower port numbers have higher PoE priorities. That is, the switch withdraws power (or disconnects) those ports with the *highest* port number(s).

The system keeps dropping ports, using the algorithm you selected with the disconnect ports command, until the measured inline power for the slot is lower than the reserved inline power.

To configure the disconnect precedence for the switch, use the following command:

```
configure inline-power disconnect-precedence [deny-port | lowest-priority]
```

To return the disconnect precedence to the default value of deny port, use the following command:

```
unconfigure inline-power disconnect-precedence
```

To display the currently configured disconnect precedence, use the following command:

```
show inline-power
```

Configuring the PoE Port Priority

Summit X250e-48p, X440-24p, X450e-48p, X460-24p, X460-48p, and Modular PoE Switches Only.

You can configure the PoE port priority to be low, high, or critical. The default value is low.

If you configure the disconnect precedence as lowest priority and the PDs request power in excess of the switch's or slot's reserved power budget, the system allocates power to those ports with the highest priorities first.

If several ports have the same PoE priority, the lower port numbers have higher PoE priorities. That is, the switch withdraws power (or disconnects) those ports with the *highest* port number(s).

To configure PoE port priority, use the following command:

```
configure inline-power priority [critical | high | low] ports <port_list>
```

To reset the port priority to the default value of low, use the following command:

```
unconfigure inline-power priority ports [all | <port_list>]
```

To display the PoE port priorities, use the following command:

```
show inline-power configuration ports <port_list>
```

Configuring the Usage Threshold

The system generates an SNMP event after a preset percentage of the reserved power for any slot or total power for a stand-alone switch is actually used by a connected PD. This preset percentage is called the usage threshold and is the percentage of the measured power to the budgeted power for each slot or total power for a stand-alone switch.

On modular switches, although the percentage of used to budgeted power is measured by each PoE module, you set the threshold for sending the event for the entire switch. That is, after any PoE module passes the configured threshold, the system sends an event.

The default value for this usage threshold is 70%. You can configure the usage threshold to be any integer between 1% and 99%.

To configure the threshold percentage of budgeted power used on a slot or the total power on a stand-alone switch that causes the system to generate an SNMP event and EMS message, use the following command:

```
configure inline-power usage-threshold <threshold>
```

To reset the threshold that causes the system to generate an SNMP event and EMS message per slot to 70% for measured power compared to budgeted power, use the following command:

```
unconfigure inline-power usage-threshold
```

To display the currently configured usage threshold, use the following command:

```
show inline-power
```

Configuring the Switch to Detect Legacy PDs

The PoE device can detect non-standard, legacy PDs, which do not conform to the IEEE 802.3af standard, using a capacitance measurement. However, you must specifically enable the switch to detect these non-standard PDs; the default value for this detection method is disabled.

This configuration applies to the entire switch; you cannot configure the detection method per slot.

The switch detects PDs through capacitance only if *both* of the following conditions are met:

- The legacy detection method is enabled.
- The switch unsuccessfully attempted to discover the PD using the standard resistance measurement method.

To enable a switch to detect legacy, non-standard PDs for a specified slot, use the following command:

```
enable inline-power legacy slot <slot>
```

To enable the switch to detect legacy PDs on a switch, use the following command:

```
enable inline-power legacy
```

To reset the switch to the default value which does not detect legacy PDs, on a specified slot, use the following command:

```
disable inline-power legacy slot <slot>
```

To reset the switch to the default value which does not detect legacy PDs, use the following command:

```
disable inline-power legacy
```

To display the status of legacy detection, use the following command:

```
show inline-power
```

Configuring the Operator Limit

You configure the maximum amount of power that the specified port can deliver to the connected PD, in milliwatts (mW). For PoE, the default value is 15400 mW, and the range is 3000 to 16800 mW. For PoE+, the default value is 30000 mW, and the range is 3000 to 30000 mW.

If the operator limit for a specified port is less than the power drawn by the legacy PD, the legacy PD is denied power.

To set the operator limit on specified ports, which limits how much power a PD can draw from that port use the following command:

```
configure inline-power operator-limit <milliwatts> ports [all |<port_list>]
```

To reset the operator limit to the default value of 15.4 W for PoE or 30 W for PoE+, use the following command:

```
unconfigure inline-power operator-limit ports [all |<port_list>]
```

To display the current operator limit on each port, use the following command:

```
show inline-power configuration ports <port_list>
```

Configuring PoE Port Labels

You can assign labels to a single or group of PoE ports using a string of up to 15 characters. To assign a label to PoE ports, use the following command:

```
configure inline-power label <string> ports <port_list>
```

To rename a port or to return it to a blank label, reissue the command.

To display the PoE port labels, use the following command:

```
show inline-power configuration ports <port_list>
```

Power Cycling Connected PDs

To power cycle a connected PD without losing the power allocated to its port, use the following command:

```
reset inline-power ports <port_list>
```

Adding an S-PoE Daughter Card to an Existing Configuration

G48Tc and G48Te2 I/O Modules for the BlackDiamond 8800 Series Switches.

This section describes how to add an S-PoE daughter card to an EXOS configuration that has already been saved without PoE capabilities. The example in this section uses the G48Te2 module.

The following output displays the results of the `show slot` command with slot 4 configured:

```
BD-8810.6 # show slot
Slots      Type              Configured          State              Ports  Flags
-----
Slot-1     G48Tc             G48Tc              Operational        48    MB
Slot-2                               Empty              Empty              0
Slot-3                               Empty              Empty              0
Slot-4     G48Te2            G48Te2             Operational        48    MB
Slot-5     G8Xc              G8Xc               Operational        8     MB
Slot-6     10G1Xc           10G1Xc            Operational        1     MB
Slot-7     10G4X            10G4X             Operational        4     MB
Slot-8                               Empty              Empty              0
Slot-9                               Empty              Empty              0
Slot-10                              Empty              Empty              0
MSM-A      MSM-48c          MSM-48c           Operational        0
MSM-B      MSM-48c          MSM-48c           Operational        0
```

```
Flags: M - Backplane link to Master is Active
       B - Backplane link to Backup is also Active
       D - Slot Disabled
       I - Insufficient Power (refer to "show power budget")
```

To configure a module for the PoE daughter card, follow these steps:

- 1 Remove the G48Te2 module.
- 2 Attach the PoE daughter card to the G48Te2 module (as described in installation document provided with the daughter card).

- 3 Re-insert G48Te2 module with the PoE daughter card attached. The following output displays the results of the show slot command after the card is attached:**

```
* BD-8810.20 # show slot
Slots      Type                Configured          State      Ports  Flags
-----
Slot-1     G48Tc                G48Tc              Operational 48     MB
Slot-2
Slot-3
Slot-4     G48Te2 (PoE)         G48Te2              Operational 48     MB
Slot-5     G8Xc                 G8Xc                Operational 8      MB
Slot-6     10G1Xc              10G1Xc              Operational 1      MB
Slot-7     10G4X               10G4X               Operational 4      MB
Slot-8
Slot-9
Slot-10
MSM-A      MSM-48c              Operational         0
MSM-B      MSM-48c              Operational         0
```

```
Flags : M - Backplane link to Master is Active
        B - Backplane link to Backup is also Active
        D - Slot Disabled
        I - Insufficient Power (refer to "show power budget")
```

You can expect to see the following log messages generated by the system after you have attached the card:

```
<Warn:HAL.Card.Warning> MSM-A: Powering on mismatch card - cfg: G48Te2 actual:
G48Te2 (PoE)
<Warn:HAL.Card.Warning> MSM-B: Powering on mismatch card - cfg: G48Te2 actual:
G48Te2 (PoE)
```

- 4 Change the slot module type to include POE by executing the command**
configure slot 4 module G48Te2 (PoE).

**NOTE**

You must configure the slot as (PoE) before the power feature is accessible or enabled.

The following output displays the results of the show slot command after this command has been executed:

```
* BD-8810.20 # show slot
Slots      Type                Configured          State      Ports  Flags
-----
Slot-1     G48Tc                G48Tc              Operational 48     MB
Slot-2
Slot-3
Slot-4     G48Te2 (PoE)         G48Te2 (PoE)       Operational 48     MB
Slot-5     G8Xc                 G8Xc                Operational 8      MB
Slot-6     10G1Xc              10G1Xc              Operational 1      MB
Slot-7     10G4X               10G4X               Operational 4      MB
Slot-8
Slot-9
Slot-10
MSM-A      MSM-48c              Operational         0
MSM-B      MSM-48c              Operational         0
```

```

Flags : M - Backplane link to Master is Active
        B - Backplane link to Backup is also Active
        D - Slot Disabled
        I - Insufficient Power (refer to "show power budget")

```

- 5 Save the configuration by executing the command `save configuration`.

Displaying PoE Settings and Statistics

You can display the PoE status, configuration, and statistics for the system, slot, and port levels. This section describes the following topics:

- [Clearing Statistics on page 451](#)
- [Displaying System Power Information on page 451](#)
- [Displaying Slot PoE Information on Modular Switches on page 452](#)
- [Displaying PoE Status and Statistics on Stand-alone Switches on page 453](#)
- [Displaying Port PoE Information on page 453](#)

Clearing Statistics

You can clear the PoE statistics for specified ports or for all ports. To clear the statistics and reset the counters to 0, use the following command:

```
clear inline-power stats ports [all | <port_list>]
```

Displaying System Power Information

You can display the status of the inline power for the system and, for additional information, display the power budget of the switch.

Displaying System PoE Status

To display the PoE status for the switch, use the following command:

```
show inline-power
```

The command provides status for the following areas:

- Configured inline power status—The status of the inline power for the switch: enabled or disabled.
- System power surplus—The surplus amount of power on the system, in watts, available for budgeting.
- Redundant power surplus—The amount of power on the system, in watts, available for budgeting if one power supply is lost.
- System power usage threshold—The configured power usage threshold for each slot, shown as a percentage of budgeted power. After this threshold has been passed on any slot, the system sends an SNMP event and logs a message.
- Disconnect precedence—The method of denying power to PDs if the budgeted power on any slot is exceeded.
- Legacy mode—The status of the legacy mode, which allows detection of non-standard PDs.

The output indicates the following inline power status information for each slot:

- Inline power status—The status of inline power. The status conditions are:
 - Enabled
 - Disabled
- Firmware status—The operational status of the slot. The status conditions are:
 - Operational
 - Not operational
 - Disabled
 - Subsystem failure
 - Card not present
 - Slot disabled
- Budgeted power—The amount of inline power, in watts, that is reserved and available to the slot.
- Measured power—The amount of power, in watts, that is currently being used by the slot.

Displaying System Power Data

Additionally, you can view the distribution of power, as well as currently required and allocated power, on the entire modular switch including the power supplies by using the following command:

```
show power budget
```

Displaying Slot PoE Information on Modular Switches

You can display PoE status and statistics per slot.

Displaying Slot PoE Status

To display PoE status for each slot, use the following command:

```
show inline-power slot <slot>
```

The command provides the following information:

- Inline power status—The status of inline power. The status conditions are:
 - Enabled
 - Disabled
- Firmware status—The operational status of the slot. The status conditions are:
 - Operational
 - Not operational
 - Disabled
 - Subsystem failure
 - Card not present
 - Slot disabled
- Budgeted power—The amount of power, in watts, that is available to the slot.
- Measured power—The amount of power, in watts, that is currently being used by the slot.

Displaying Slot PoE Statistics

To display the PoE statistics for each slot, use the following command:

```
show inline-power stats slot <slot>
```

The command provides the following information:

- Firmware status—Displays the firmware state:
 - Operational
 - Not operational
 - Disabled
 - Subsystem failure
 - Card not present
 - Slot disabled
- Firmware revision—Displays the revision number of the PoE firmware
- Total ports powered—Displays the number of ports powered on specified slot
- Total ports awaiting power—Displays the number of remaining ports in the slot that are not powered
- Total ports faulted—Displays the number of ports in a fault state
- Total ports disabled—Displays the number of ports in a disabled state

Displaying PoE Status and Statistics on Stand-alone Switches

To display the PoE statistics for the switch, use the following command:

```
show inline-power stats
```

The command provides the following information:

- Firmware status—Displays the firmware state:
 - Operational
 - Not operational
 - Disabled
 - Subsystem failure
- Firmware revision—Displays the revision number of the PoE firmware
- Total ports powered—Displays the number of ports powered on specified slot
- Total ports awaiting power—Displays the number of remaining ports in the slot that are not powered
- Total ports faulted—Displays the number of ports in a fault state
- Total ports disabled—Displays the number of ports in a disabled state

Displaying Port PoE Information

You can display the PoE configuration, status, and statistics per port.

Displaying Port PoE Configuration

To display PoE configuration for each port, use the following command:

```
show inline-power configuration ports <port_list>
```

This command provides the following information:

- Config—Indicates whether the port is enabled to provide inline power:
 - Enabled: The port can provide inline power.
 - Disabled: The port cannot provide inline power.
- Operator Limit—Displays the configured limit, in milliwatts, for inline power on the port.
- Label—Displays a text string, if any, associated with the port (15 characters maximum).

Displaying Port PoE Status

To display the PoE status per port, use the following command:

```
show inline-power info {detail} ports <port_list>
```

This command provides the following information:

- State—Displays the port power state:
 - Disabled
 - Searching
 - Delivering
 - Faulted
 - Disconnected
 - Other
 - Denied
- PD's power class—Displays the class type of the connected PD:
 - "----": disabled or searching
 - "class0": class 0 device
 - "class1": class 1 device
 - "class2": class 2 device
 - "class3": class 3 device
 - "class4": class 4 device
- Volts—Displays the measured voltage. A value from 0 to 2 is valid for ports that are in a searching or discovered state.
- Curr—Displays the measured current, in milliamperes, drawn by the PD.
- Power—Displays the measured power, in watts, supplied to the PD.
- Fault—Displays the fault value:
 - None
 - UV/OV fault
 - UV/OV spike
 - Over current
 - Overload
 - Undefined

- Underload
- HW fault
- Discovery resistance fail
- Operator limit violation
- Disconnect
- Discovery resistance, A2D failure
- Classify, A2D failure
- Sample, A2D failure
- Device fault, A2D failure
- Force on error

The detail command lists all inline power information for the selected ports. Detail output displays the following information:

- Configured Admin State
- Inline Power State
- MIB Detect Status
- Label
- Operator Limit
- PD Class
- Max Allowed Power
- Measured Power
- Line Voltage
- Current
- Fault Status
- Detailed Status
- Priority

Displaying Port PoE Statistics

To display the PoE statistics for each port, use the following command:

```
show inline-power stats ports <port_list>
```

The command provides the following information:

- State—Displays the port power state:
 - Disabled
 - Searching
 - Delivering
 - Faulted
 - Disconnected
 - Other
 - Denied
- PD's power class—Displays the class type of the connected PD:
 - "-----": disabled or searching
 - "class0": class 0 device

- “class1”: class 1 device
- “class2”: class 2 device
- “class3”: class 3 device
- “class4”: class 4 device
- Absent—Displays the number of times the port was disconnected
- InvSig—Displays the number of times the port had an invalid signature
- Denied—Displays the number of times the port was denied
- Over-current—Displays the number of times the port entered an overcurrent state
- Short—Displays the number of times the port entered undercurrent state

11

CHAPTER

Status Monitoring and Statistics

This chapter includes the following sections:

- [Overview on page 457](#)
- [Viewing Port Statistics on page 458](#)
- [Viewing Port Errors on page 459](#)
- [Using the Port Monitoring Display Keys on page 460](#)
- [Viewing VLAN Statistics on page 461](#)
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- [Using the System Health Checker on page 469](#)
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- [Viewing Fan Information on page 494](#)
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- [Monitoring CPU Utilization on page 521](#)

Viewing statistics on a regular basis allows you to see how well your network is performing. If you keep simple daily records, you can see trends emerging and notice problems arising before they cause major network faults. In this way, statistics can help you get the best out of your network.

Overview

The status monitoring facility provides information about the switch. This information may be useful for your technical support representative if you have a problem. ExtremeXOS software includes many command line interface (CLI) `show` commands that display information about different switch functions and facilities.

**NOTE**

For more information about `show` commands for a specific ExtremeXOS feature, see the appropriate chapter in this guide.

Viewing Port Statistics

ExtremeXOS software provides a facility for viewing port statistical information. The summary information lists values for the current counter for each port on each operational module in the system. The switch automatically refreshes the display (this is the default behavior).

You can also display a snapshot of the real-time port statistics at the time you issue the command and view the output in a page-by-page mode. This setting is not saved; therefore, you must specify the `no-refresh` parameter each time you want a snapshot of the port statistics.

Values are displayed to nine digits of accuracy.

To view port statistics, use the following command:

```
show ports {<port_list> | stack-ports <stacking-port-list>} statistics {no-refresh}
```

The switch collects the following port statistical information:

- **Link State**—The current state of the link. Options are:
 - Active (A)—The link is present at this port.
 - Ready (R)—The port is ready to accept a link.
 - Loopback (L)—The port is configured for WANPHY loopback.
 - Not Present (NP)—The port is configured, but the module is not installed in the slot (modular switches only).
- **Transmitted Packet Count (TX Pkt Count)**—The number of packets that have been successfully transmitted by the port.
- **Transmitted Byte Count (TX Byte Count)**—The total number of data bytes successfully transmitted by the port.
- **Received Packet Count (RX Pkt Count)**—The total number of good packets that have been received by the port.
- **Received Byte Count (RX Byte Count)**—The total number of bytes that were received by the port, including bad or lost frames. This number includes bytes contained in the Frame Check Sequence (FCS), but excludes bytes in the preamble.
- **Received Broadcast (RX Bcast)**—The total number of frames received by the port that are addressed to a broadcast address.
- **Received Multicast (RX Mcast)**—The total number of frames received by the port that are addressed to a multicast address.

You can also view port statistics for SummitStack stacking ports using the following command:

```
show ports stack-ports {<stacking-port-list>} statistics {no-refresh}
```

Viewing Port Errors

The switch keeps track of errors for each port and automatically refreshes the display (this is the default behavior).

You can also display a snapshot of the port errors at the time you issue the command and view the output in a page-by-page mode. This setting is not saved; therefore, you must specify the `no-refresh` parameter each time you want a snapshot of the port errors.

To view port transmit errors, use the following command:

```
show ports {<port_list> | stack-ports <stacking-port-list>} txerrors {no-refresh}
```

The switch collects the following port transmit error information:

- Port Number—The number of the port.
- Link State—The current state of the link. Options are:
 - Active (A)—The link is present at this port.
 - Ready (R)—The port is ready to accept a link.
 - Loopback (L)—The port is configured for WANPHY loopback.
 - Not Present (NP)—The port is configured, but the module is not installed in the slot (modular switches only).
- Transmit Collisions (TX Coll)—The total number of collisions seen by the port, regardless of whether a device connected to the port participated in any of the collisions.
- Transmit Late Collisions (TX Late Coll)—The total number of collisions that have occurred after the port's transmit window has expired.
- Transmit Deferred Frames (TX Deferred)—The total number of frames that were transmitted by the port after the first transmission attempt was deferred by other network traffic.
- Transmit Errored Frames (TX Errors)—The total number of frames that were not completely transmitted by the port because of network errors (such as late collisions or excessive collisions).
- Transmit Lost Frames (TX Lost)—The total number of transmit frames that do not get completely transmitted because of buffer problems (FIFO underflow).
- Transmit Parity Frames (TX Parity)—The bit summation has a parity mismatch.

To view port receive errors, use the following command:

```
show ports {<port_list> | stack-ports <stacking-port-list>} rxerrors {no-refresh}
```

The switch collects the following port receive error information:

- Port Number
- Link State—The current state of the link. Options are:
 - Active (A)—The link is present at this port.
 - Ready (R)—The port is ready to accept a link.
 - Not Present (NP)—The port is configured, but the module is not installed in the slot (modular switches only).
 - Loopback (L)—The port is in Loopback mode.
- Receive Bad CRC Frames (RX CRC)—The total number of frames received by the port that were of the correct length but contained a bad FCS value.
- Receive Oversize Frames (RX Over)—The total number of good frames received by the port greater than the supported maximum length of 1,522 bytes.

- Receive Undersize Frames (RX Under)—The total number of frames received by the port that were less than 64 bytes long.
- Receive Fragmented Frames (RX Frag)—The total number of frames received by the port that were of incorrect length and contained a bad FCS value.
- Receive Jabber Frames (RX Jabber)—The total number of frames received by the port that were greater than the support maximum length and had a Cyclic Redundancy Check (CRC) error.
- Receive Alignment Errors (RX Align)—The total number of frames received by the port with a CRC error and not containing an integral number of octets.
- Receive Frames Lost (RX Lost)—The total number of frames received by the port that were lost because of buffer overflow in the switch.

For SummitStack stacking ports, you can also view transmit and receive errors with the following commands:

```
show ports stack-ports {<stacking-port-list>} txerrors {no-refresh}
show ports stack-ports {<stacking-port-list>} rxerrors {no-refresh}
```

Information displayed is identical to the details displayed for non-stacking ports.

Using the Port Monitoring Display Keys

Table 53 describes the keys used to control the displays that appear if you use any of the `show ports` commands without specifying the `no-refresh` parameter (this is the default behavior).

Table 53: Port Monitoring Display Keys with Auto-Refresh Enabled

Key(s)	Description
U	Displays the previous page of ports.
D	Displays the next page of ports.
[Esc]	Exits from the screen.
0	Clears all counters.
[Space]	Cycles through the following screens: <ul style="list-style-type: none"> • Packets per second • Bytes per second • Percentage of bandwidth NOTE: Available only using the <code>show ports utilization</code> command.

Table 54 describes the keys used to control the displays that appear if you use any of the `show ports` commands and specify the `no-refresh` parameter.

Table 54: Port Monitoring Display Keys with Auto-Refresh Disabled

Key	Description
Q	Exits from the screen.
[Space]	Displays the next page of ports.

Viewing VLAN Statistics

BlackDiamond 8000 series modules, SummitStack and Summit family switches only.

ExtremeXOS software provides the facility for configurable VLAN statistics gathering and display of packet and byte counters on the port level and on the VLAN level.

Configuring VLAN Statistics

To configure the switch to start counting VLAN statistics, use the following commands:

```
clear counters
configure ports [<port_list>|all] monitor vlan <vlan_name> {rx-only | tx-only}
```

To view VLAN statistics at the port level, use the following command:

```
show ports [<port_list>] vlan statistics {no-refresh}
```

The switch collects and displays the following statistics:

- Port—The designated port.
- VLAN—The associated VLANs.
- Rx Frames Count—The total number of frames successfully received by the port on the designated VLAN.
- Rx Byte Count—The total number of bytes that were received by the port on the designated VLAN.
- Tx Frame Count—The total number of frames that were transmitted by the port on the designated VLAN.
- Tx Byte Count—The total number of bytes that were transmitted by the port on the designated VLAN.

Frame and byte counters are also displayed through SNMP.

To view VLAN statistics at the VLAN level, use the following command:

```
show vlan [<vlan_name>] statistics {no-refresh}
```

The switch collects and displays the following statistics:

- VLAN—The designated VLAN.
- Rx Total Frames —The total number of frames successfully received by the port.
- Rx Byte Count—The total number of bytes that were received by the port.
- Tx Total Frames—The total number of frames that were transmitted by the port.
- Tx Byte Count—The total number of bytes that were transmitted by the port.

To stop counting VLAN statistics use the following command:

```
unconfigure ports [<port_list>|all] monitor vlan <vlan_name>
```



NOTE

While using VLAN statistics on Summit family switches or BlackDiamond 8000 series modules, traffic also matching egress ACL counters will cause the VLAN statistics Tx counter to not increment.

Guidelines and Limitations

The following describes guidelines for this feature.

- Support for VMAN statistics are provided in the same manner as VLAN statistics. CLI commands use the same syntax as used with monitoring VLANs including the use of the `vlan` keyword in CLI commands. SNMP access uses the same MIB objects as used for VLAN statistics.

Statistics for VLANs encapsulated within VMANs are not supported.

- Only BlackDiamond 8900 series modules and Summit X460, X480, X650, and X670 switches provide support for both receive and transmit statistics.
- BlackDiamond 8000 series modules and Summit family switches provide support only for byte counters.
- All of the counters supported are 64 bit counters. No indication of counter rollover is supported.
- Packets originating from the switch's CPU or forwarded by the CPU may not be reflected in transmit statistics.
- On BlackDiamond 12800 series switches, you can monitor up to 1000 VLANs on the same port by issuing the command multiple times. On BlackDiamond 8000 a-, c-, e-, xl-, and xm-series modules and Summit family switches, the number of VLANs that can be monitored is dependent on filtering resources on the involved module or switch.
- On BlackDiamond 12800 GM-20XT, GM-20XTR, XM-2HR, and GM-20T modules, each 10 port group shares the VLAN statistics counter. On GM-20XT, GM-20XTR, and GM-20T modules, a 10 port group consists of ports 1–10 and 11–20. On XM-2HR modules, a 10 port group consists of ports 2–11. Because of this, only one Gig port per group can be monitored for a VLAN. If multiple ports in the same group are monitored in the same VLAN, then the VLAN statistics may not be accurate.

Performing Switch Diagnostics

The switch provides a facility for running normal or extended diagnostics. In simple terms, a normal routine performs a simple ASIC and packet loopback test on all ports, and an extended routine performs extensive ASIC, ASIC-memory, and packet loopback tests. By running and viewing the results from diagnostic tests, you can troubleshoot and resolve network issues.

On BlackDiamond X8 and 8800 series switches, you can run the diagnostic routine on Input/Output (I/O) modules, management modules (MSMs/MMs), or Fabric modules (BlackDiamond X8 series only) without affecting the operation of the rest of the modules. The module under test is taken offline while the diagnostic test is performed. Traffic to and from the ports on that module is temporarily unavailable. When the diagnostic test is complete, the module is reset and becomes operational again.

On Summit family switches, you run the diagnostic routine on the switch or on the stacking ports. Running the switch or stacking port diagnostic routine affects system operation; the switch is unavailable during the diagnostic test.



NOTE

Before running diagnostics, you must power on the External Power Supply (EPS) when it is connected to the switch.

When you run diagnostics on an I/O module, MSM/MM module, Fabric module (BlackDiamond X8 series only), or a Summit family switch, the switch verifies that the:

- Registers can be written to and read from correctly.
- Memory addresses are accessed correctly.
- Application-Specific Integrated Circuit (ASICs) and Central Processing Unit (CPUs) operate as required.
- Data and control fabric connectivity is active (modular switches only).
- External ports can send and receive packets.
- Sensors, hardware controllers, and LEDs are working correctly.

**NOTE**

Before running slot diagnostics on a modular switch, you must have at least one MSM/MM installed in the chassis.

When you run diagnostics on the SummitStack stacking ports, the switch completes a hardware test to ensure that the stacking ports are operational.

The remainder of this section describes the following topics:

- [Running Diagnostics on page 463](#)
- [SummitStack or Summit Family Switches on page 464](#)
- [Observing LED Behavior During a Diagnostic Test on page 465](#)
- [Displaying Diagnostic Test Results on page 469](#)

Running Diagnostics

BlackDiamond X8 and 8800 Series Switches

If you run the diagnostic routine on an I/O or Fabric module (BlackDiamond X8 series only), that module is taken offline while the diagnostic test is performed. Traffic to and from the ports on that I/O or Fabric (BlackDiamond X8 series only) module is temporarily unavailable. When the diagnostic test is complete, the module is reset and becomes operational again.

If you run diagnostics on an MSM/MM, that module is taken offline while the diagnostics test is performed. When the diagnostic test is complete, the MSM/MM reboots and becomes operational again.

If you run diagnostics on the primary MSM/MM, the backup MSM/MM assumes the role of the primary and takes over switch operation. After the MSM/MM completes the diagnostic routine and reboots, you can initiate failover from the new primary MSM/MM to the original primary MSM/MM. Before initiating failover, confirm that both MSMs/MMs are synchronized using the `show switch` command. If the MSMs/MMs are synchronized, initiate failover using the `run msm-failover` command. For more detailed information about system redundancy and MSM/MM failover, see “[Understanding System Redundancy—Modular Switches and SummitStack Only](#)” on page 81.

Run diagnostics on one MSM/MM at a time. After you run the diagnostic routine on the first MSM/MM, use the `show switch` command to confirm that both MSMs/MMs are up, running, and synchronized before running diagnostics on the second MSM/MM.

After the switch runs the diagnostic routine, test results are saved in the module's EEPROM and messages are logged to the syslog.

To run diagnostics on I/O, Fabric (BlackDiamond X8 series only), or MSM/MM modules, use the following command:

```
run diagnostics [extended | normal | stack-port] {slot [<slot> | A | B]}
```

Where the following is true:

- `extended`—Takes the switch fabric and ports offline and performs extensive ASIC, ASIC-memory, and packet loopback tests. Extended diagnostic tests take approximately 15 to 20 minutes to complete. The CPU is not tested. Console access is available during extended diagnostics.
If you have a Power over Ethernet (PoE) module installed, the switch also performs an extended PoE test, which tests the functionality of the inline power adapter.
- `normal`—Takes the switch fabric and ports offline and performs a simple ASIC and packet loopback test on all ports.
- `<slot>`—Specifies the slot number of an I/O or Fabric (BlackDiamond X8 series only) module. When the diagnostic test is complete, the system attempts to bring the module back online.



NOTE

BlackDiamond 8800 series switches—To run diagnostics on the management portion of the master MSM, specify slot A or B. If an I/O subsystem is present on the MSM, then that I/O subsystem will be non-operational until diagnostics are completed.

BlackDiamond 8810 switch—If you run diagnostics on slots 5 and 6 with an MSM installed in those slots, the diagnostic routine tests the I/O subsystem of the MSM.

BlackDiamond 8806 switch—if you run diagnostics on slots 3 and 4 with an MSM installed in those slots, the diagnostic routine tests the I/O subsystem of the MSM.

- `A | B`—Specifies the slot letter of the primary MSM. The diagnostic routine is performed when the system reboots. Both switch fabric and management ports are taken offline during diagnostics.



NOTE

BlackDiamond X8 and 8800 series switches do not allow you to run diagnostics on a module that has been disabled. Command line interface message: `Cannot run diags because I/O card is not Operational or Offline Current state is Down.`

After the diagnostic routine has finished, use the `enable slot <slot> | FM-1 | FM-2 | FM-3 | FM-4` command to bring the module back online and operational.

SummitStack or Summit Family Switches

Diagnostics cannot be run on a SummitStack. You need to disable stacking on the switch to be tested, reboot the switch before logging in, and then run the diagnostics. Once the diagnostics routine is complete, the switch reboots again. Log in, enable stacking mode, and reboot the switch again. Upon reboot, the switch rejoins the stack. You can then use the `show diagnostics` command to see the last diagnostic result of any or all switches in the SummitStack.

If you run the diagnostic routine on Summit family switches, the switch reboots and then performs the diagnostic test. During the test, traffic to and from the ports on the switch is temporarily unavailable. When the diagnostic test is complete, the switch reboots and becomes operational again.

To run the diagnostic routine on the stack ports, you need a dedicated stacking cable that connects stack port 1 to stack port 2, which are located at the rear of the switch. The stacking cable is available from Extreme Networks. The switch performs a hardware test to confirm that the stack ports are operational; traffic to and from the ports on the switch is temporarily unavailable. This Bit Error Rate Test (BERT) provides an analysis of the number of bits transmitted in error.

**NOTE**

The stack ports diagnostic does not require a dedicated cable to be connected for the following SummitStack-V80 plugins: VIM2-SSV80 on X480 and SS-V80 on X460/E4G-400. For this hardware, the stack port diagnostic implements an internal loopback within the module.

After the switch runs the diagnostic routine, test results saved to the switch's EEPROM and messages are logged to the syslog.

To run diagnostics on Summit family switches, use the following command:

```
run diagnostics [extended | normal | stack-port] {slot [<slot> | A | B]}
```

Where the following is true:

- `extended`—Reboots the switch and performs extensive ASIC, ASIC-memory, and packet loopback tests. Extended diagnostic tests take a maximum of 5 minutes. The CPU is not tested.
- `normal`—Reboots the switch and performs a simple ASIC and packet loopback test on all ports.
- `stack-port`—Performs a BERT on the stacking ports and reboots the switch.

Observing LED Behavior During a Diagnostic Test

Whether you run a diagnostic test on an I/O module, MSM/MM, or a Summit family switch, LED activity occurs during and immediately following the test. The LED behavior described in this section relates only to the behavior associated with a diagnostic test. For more detailed information about all of the I/O module, MSM/MM, and switch LEDs, see the hardware documentation which is listed in the Preface.

I/O Module LED Behavior—BlackDiamond 8800 Series Switches

Table 55 describes the BlackDiamond 8800 series switch I/O module LED behavior during a diagnostic test.

Table 55: BlackDiamond 8800 Series Switch I/O Module LED Behavior

LED	Color	Indicates
DIAG	Amber blinking	Diagnostic test in progress.
	Amber	Diagnostic failure has occurred.
	Green	Diagnostic test has passed.
Stat	Amber blinking	Configuration error, code version error, diagnostic failure, or other severe module error.
	Off	Diagnostic test in progress, or diagnostic failure has occurred.

After the I/O module completes the diagnostic test, or the diagnostic test is terminated, the DIAG and the Status LEDs are reset. During normal operation, the DIAG LED is off and the Status LED blinks green.

MSM LED Behavior—BlackDiamond 8800 Series Switches

This section describes the MSM behavior during a diagnostic test.

After the I/O modules complete the diagnostic test, or the diagnostic test is terminated, the DIAG and the Status LEDs are reset. During normal operation, the DIAG LED is off and the Status LED blinks green. If you start another diagnostic test, the LED returns to blinking amber.

MSM LED Behavior—BlackDiamond 12800 Series Switches

Table 56 describes the MSM LED behavior during a diagnostic test for the R-series and non R-series MSM modules installed in the BlackDiamond 12800 series switches.



NOTE

You cannot mix R-series and non R-series MSM or I/O modules in the chassis.

Table 56: BlackDiamond 12800 Series Switch MSM LED Behavior

LED	Color	Indicates
SYS	Amber blinking	Diagnostic test in progress.
	Amber	Diagnostic failure has occurred.
MSTR	Off	Normal operation for diagnostics.

After the MSM completes the diagnostic test, or the diagnostic test is terminated, the SYS LED is reset. During normal operation, the SYS LED blinks green.

I/O Blades LED Behavior—BlackDiamond 20800 Series Switches

Table 57 describes the BlackDiamond 20800 series switch I/O Blade LED behavior during a diagnostic test.

Table 57: BlackDiamond 20800 Series Switch I/O Blades LED Behavior

LED	Color	Indicates
Status	Green blinking	Normal operation.
	Amber blinking	Configuration error, code version error, diagnostics failure, or other severe module error.
DIAG	Off	No power.
	Off	Normal operation
	Amber blinking	Diagnostics in progress
Port x	Amber	Diagnostic failure
	Green	Link up
	Green blinking	Disabled
	Amber blinking	Packet activity
	Off	Link down

MM LED Behavior—BlackDiamond 20800 Series Switches

Table 58 describes the BlackDiamond 20800 series switch MM LED behavior during a diagnostic test.

Table 58: BlackDiamond 20800 Series Switch MM LED Behavior

LED	Color	Indicates
SYS	Green blinking	Normal operation is occurring.
	Amber blinking	Diagnostic test is in progress.
	Amber	Diagnostic failure has occurred.
	Off	Switch is not receiving power.
MSTR	Green	Module is operating as master.
	Amber	Module is operating as slave.
ENV	Green	Environment (temperature, fan, power supply) is operating properly
	Amber	Environmental failure has occurred.
ERR	Amber	A critical software error has been logged since power up.
Link/ Activity	Off	Normal operation is occurring.
	Off	MM Port Link is down
	Green	MM Port Link is up.
	Amber	Packet activity is occurring.

XFM LED Behavior—BlackDiamond 20800 Series Switches

Table 59 describes the BlackDiamond 20800 series switch XFM LED behavior during a diagnostic test.

Table 59: BlackDiamond 20800 Series Switch XFM LED Behavior

LED	Color	Indicates
Status	Green blinking	Normal operation is occurring.
	Amber blinking	Configuration error, code version error, diagnostics failure, or other severe module error.
Power	Off	No power.
	Green	Power present.
	Off	No power.

I/O and Fabric Module LED Behavior—BlackDiamond X8 Switch

Table 60 describes the BlackDiamond X8 switch I/O and fabric module LED behavior during a diagnostic test. After the I/O or Fabric module completes the diagnostic test, or the diagnostic test is terminated, the DIAG and the Status LEDs are reset. During normal operation, the DIAG LED is off and the Status LED blinks green.

Table 60: BlackDiamond X8 Series Switch I/O and Fabric Module LED Behavior

LED	Color	Indicates
DIAG	Amber blinking	Diagnostic test in progress
	Amber	Diagnostic failure has occurred
Status	Amber blinking	Configuration error, code version error, or other severe module error
	Green blinking	Normal operation

MM LED Behavior—BlackDiamond X8 Switch

Table 61 describes the BlackDiamond X8 switch MM LED behavior during a diagnostic test. After the MM completes the diagnostic test, or the diagnostic test is terminated, the SYS LED is reset. During normal operation, the status LED blinks green.

Table 61: BlackDiamond X8 Series Switch MM LED Behavior

LED	Color	Indicates
SYS	Amber blinking	Diagnostic test in progress
	Amber	Diagnostic failure has occurred

LED Behavior—Summit Family Switches

Table 62 describes the Summit family switches LED behavior during a diagnostic test.

Table 62: Summit Family Switch LED Behavior

LED	Color	Indicates
MGMT	Green blinking	Normal operation is occurring.
	Amber blinking	Diagnostic test in progress.

While diagnostic tests are running, the MGMT LED blinks amber. If a diagnostic test fails, the MGMT LED continues to blink amber. During normal operation, the MGMT LED blinks green.

Displaying Diagnostic Test Results

To display the status of the last diagnostic test run on the switch, use the following command:

```
show diagnostics {[[<cr>] | slot [<slot> | A | B]}
```



NOTE

The `slot`, `A`, and `B` parameters are available only on modular switches.

Using the System Health Checker

The system health checker is a useful tool to monitor the overall health of your system. Depending on your platform, the software performs a proactive, preventive search for problems by polling and reporting the health of system components, including I/O and management module processes, power supplies, power supply controllers, and fans. By isolating faults to a specific module, backplane connection, control plane, or component, the system health checker notifies you of a possible hardware fault.

This section describes the system health check functionality of the following platforms:

- BlackDiamond X8 series switches
- BlackDiamond 8800 series switches
- Summit family switches

This section also describes the following topics:

- [Enabling Diagnostic Packets on the Switch—Modular Switches Only on page 470](#)
- [Configuring Diagnostic Packets on the Switch—Modular Switches Only on page 471](#)
- [Disabling Diagnostic Packets on the Switch—Modular Switches Only on page 471](#)
- [Displaying the System Health Check Setting—All Platforms on page 471](#)

Understanding the System Health Checker

BlackDiamond 8800 and BlackDiamond X8 Series Switches Only

On BlackDiamond 8800 and BlackDiamond X8 series switches, the system health checker tests the backplane, the CPUs on the MSM/MM modules, the I/O modules, the processes running on the switch, and the power supply controllers by periodically forwarding packets and checking for the validity of the forwarded packets.

Two modes of health checking are available: polling (also known as control plane health checking) and backplane diagnostic packets (also known as data plane health checking). These methods are briefly described in the following:

- Polling is always enabled on the system and occurs every 5 seconds by default. The polling value is not a user-configured parameter. The system health checker polls the control plane health between

MSM/MMs and I/O modules, monitors memory levels on the I/O module, monitors the health of the I/O module, and checks the health of applications and processes running on the I/O module. If the system health checker detects an error, you will be notified through the switch log.

Here is an example from a BDX8:

```
<Noti:HAL.SM.ChanDsbl> MM-A: Switch fabric channel 0 provided by Fabric slot FM-1
has been disabled due to failed connection with Slot-1
```

If you find errors, contact Extreme Networks Technical Support.

- Backplane diagnostic packets are disabled by default. If you enable this feature, the system health checker tests the data link for a specific I/O module every 5 seconds by default. The MSM/MM sends and receives diagnostic packets from the I/O module to determine the state and connectivity.

If you disable backplane diagnostics, the system health checker stops sending backplane diagnostic packets.

To see any results, you need to monitor the log to see if there are any errors detected when the backplane diagnostic packets system health checker is enabled.

No log messages generated means no errors found.

Here is an example of an error found on BDX8:

```
<Warn:HAL.Sys.Warning> MM-A: Sys-Health-Check DataPath FM : slot/unit/port/modid F1-
> 1/0->0/ 1-> 0/36-> 4 rc=3
```

If you find an error, contact Extreme Networks Technical Support.

For more information about enabling and configuring backplane diagnostics, see the following sections:

- [Enabling Diagnostic Packets on the Switch—Modular Switches Only on page 470](#)
- [Configuring Diagnostic Packets on the Switch—Modular Switches Only on page 471](#)

System health check errors are reported to the syslog. If you see an error, contact Extreme Networks Technical Support.

Summit Family Switches Only

On Summit family switches, the system health checker polls and reads the switch fabric and CPU registers. Unlike the modular platforms, only polling is available on Summit family switches. Polling is always enabled on the system and occurs in the background every 10 seconds; the polling value is not a user-configured parameter.

System health check errors are reported to the syslog. If you see an error, contact Extreme Networks Technical Support. There are no health checking tests related to the stacking links in a SummitStack.

Enabling Diagnostic Packets on the Switch—Modular Switches Only

To enable diagnostic packets, use the following command:

```
enable sys-health-check slot <slot>
```

- BlackDiamond 8800 and BlackDiamond X8 series switches—By default, the system health checker tests the data link
- The 10 Gbps links (BlackDiamond 8000 a-, c-, e-, xl-, and xm-series modules)—the system health checker tests every 5 seconds for the specified slot.

**NOTE**

Enabling backplane diagnostic packets increases CPU utilization and competes with network traffic for resources.

Configuring Diagnostic Packets on the Switch—Modular Switches Only

To configure the frequency of sending backplane diagnostic packets on a BlackDiamond 8800 series or BlackDiamond X8 switch, use the following command:

```
configure sys-health-check interval <interval>
```

**NOTE**

Extreme Networks does not recommend configuring an interval of less than the default interval. Doing so can cause excessive CPU utilization.

Disabling Diagnostic Packets on the Switch—Modular Switches Only

To disable diagnostic packets, use the following command:

```
disable sys-health-check slot <slot>
```

- BlackDiamond 8800 and BlackDiamond X8 series switches—The system health checker stops sending backplane diagnostic packets to the specified slot. Polling , which is the default system health checker, remains enabled.

Displaying the System Health Check Setting—All Platforms

To display the system health check setting, including polling and how ExtremeXOS software handles faults on the switch, use the following command:

```
show switch
```

As previously described, polling is always enabled on the switch.

The system health check setting, displayed as `SysHealth check`, shows the polling setting and how ExtremeXOS handles faults. The polling setting appears as `Enabled`, and the fault handling setting appears in parenthesis next to the polling setting. For more information about the fault handling setting, see the following sections: “[Configuring Hardware Recovery—SummitStack and Summit Family Switches Only](#)” on page 474 and “[Configuring Module Recovery—Modular Switches Only](#)” on page 476.

In the following truncated output from a BlackDiamond 8810 switch, the system health check setting appears as `SysHealth check: Enabled (Normal)`:

```
SysName:          TechPubs Lab
SysName:          BD-8810Rack3
SysLocation:
SysContact:       support@extremenetworks.com, +1 888 257 3000
System MAC:       00:04:96:1F:A2:60
```

SysHealth check: Enabled (Normal)
Recovery Mode: None
System Watchdog: Enabled

System Health Check Examples: Diagnostics—Modular Switches Only

This section provides examples for using the system health checker on BlaBlackDiamond 8800 and X8 series switches. For more detailed information about the system health check commands, see the chapter “[Commands for Status Monitoring and Statistics](#)” in the *ExtremeXOS Command Reference Guide*.

Example on the BlackDiamond 8800 and BlackDiamond X8 Series Switch

This section describes a series of two examples for:

- Enabling and configuring backplane diagnostics
- Disabling backplane diagnostics

Enabling and Configuring Backplane Diagnostics. The following example:

- Enables backplane diagnostic packets on slot 3
- Configures backplane diagnostic packets to be sent every 7 seconds

Use the following procedure:

- 1 Enable backplane diagnostic packets on slot 3 using the following command:

```
enable sys-health-check slot 3
```

When you enable backplane diagnostic packets on slot 3, the timer runs at the default rate of 5 seconds.

- 2 Configure backplane diagnostic packets to be sent every 7 seconds using the following command:

```
configure sys-health-check interval 7
```



NOTE

Extreme Networks does not recommend configuring an interval of less than 5 seconds. Doing this can cause excessive CPU utilization.

Disabling Backplane Diagnostics. Building upon the previous example, the following example disables backplane diagnostics on slot 3:

```
disable sys-health-check slot 3
```

Backplane diagnostic packets are no longer sent, but the configured interval for sending backplane diagnostic packets remains at 7 seconds. The next time you enable backplane diagnostic packets, the health checker sends the backplane diagnostics packets every 7 seconds.

To return to the "default" setting of 5 seconds, configure the frequency of sending backplane diagnostic packets to 5 seconds using the following command:

```
configure sys-health-check interval 5
```

Setting the System Recovery Level

Depending on your switch model, you can configure the switch, MSM/MM, or I/O module to take action if a fault detection exception occurs. The following sections describe how to set the software and hardware recovery levels on the switch, MSM/MM, and I/O modules.



NOTE

You configure MSM/MM and I/O module recovery only on BlackDiamond X8 and BlackDiamond 8800 series switches.

This section describes the following topics:

- [Configuring Software Recovery on page 473](#)
- [Configuring Hardware Recovery—SummitStack and Summit Family Switches Only on page 474](#)
- [Configuring Module Recovery—Modular Switches Only on page 476](#)

Configuring Software Recovery

You can configure the system to either take no action or to automatically reboot the switch after a software task exception, using the following command:

```
configure sys-recovery-level [all | none]
```

Where the following is true:

- `all`—Configures ExtremeXOS to log an error to the syslog and automatically reboot the system after any software task exception.
On modular switches, this command sets the recovery level only for the MSMs/MMs. The MSM/MM should reboot only if there is a software exception that occurs on the MSM/MM. The MSM/MM should not reboot if a software exception occurs on an I/O module.
- `none`—Configures the system to take no action if a software task exception occurs. The system does not reboot, which can cause unexpected switch behavior. On a SummitStack, the `sys-recovery-level` setting applies to all active nodes.



NOTE

Use this parameter only under the guidance of Extreme Networks Technical Support personnel.

The default setting and behavior is `all`. Extreme Networks strongly recommends using the default setting.

Displaying the Software Recovery Setting

To display the software recovery setting on the switch, use the following command:

```
show switch
```

This command displays general switch information, including the software recovery level. The following truncated output from a Summit series switch displays the software recovery setting (displayed as `Recovery Mode`):

```
SysName:          TechPubs Lab
SysLocation:
SysContact:       support@extremenetworks.com, +1 888 257 3000
System MAC:       00:04:96:1F:A4:0E
Recovery Mode:    All
System Watchdog:  Enabled
```



NOTE

All platforms display the software recovery setting as `Recovery Mode`.

Configuring Hardware Recovery—SummitStack and Summit Family Switches Only

You can configure Summit family switches or SummitStack to take no action, automatically reboot, or shut down if the switch detects a hardware fault.

To configure how the switch recovers from hardware problems on a stand-alone Summit family switch, use the following command:

```
configure sys-recovery-level switch [none | reset | shutdown]
```

To configure hardware recovery on a particular active node in the SummitStack, use the following command:

```
configure sys-recovery-level slot
```

Where the following is true:

- `none`—Configures the switch to maintain its current state regardless of the detected fault. The switch does not reboot or shut down. ExtremeXOS software logs fault and error messages to the syslog.
- `reset`—Configures the switch to reboot upon detecting a hardware fault. ExtremeXOS software logs fault, error, system reset, and system reboot messages to the syslog.
- `shutdown`—Configures the switch to shut down upon detecting a hardware fault. All ports are taken offline in response to the reported errors; however, the management port remains operational for debugging purposes only. If the switch shuts down, it remains in this state across additional reboots or power cycles until you explicitly clear the shutdown state. See [“Clearing the Shutdown State” on page 476](#) for more information. ExtremeXOS logs fault, error, system reset, system reboot, and system shutdown messages to the syslog.

The default setting is `reset`.

You can configure how ExtremeXOS handles a detected fault depending on the `sys-recovery-level` setting. To configure how ExtremeXOS handles faults, use the `configure sys-health-check all level [normal | strict]` command. For detailed information about this command, see the *ExtremeXOS Command Reference Guide*.

To view the system health check settings on the switch, use the `show switch` command as described in “Displaying the System Health Check Setting—All Platforms” on page 471.

Confirmation Messages Displayed

If you configure the hardware recovery setting to either none (ignore) or shut down, the switch prompts you to confirm this action. The following is a sample shutdown message:

```
Are you sure you want to shutdown on errors? (y/n)
```

Enter `y` to confirm this action and configure the hardware recovery level. Enter `n` or press [Enter] to cancel this action.

Messages Displayed at the Startup Screen

If you configure the shutdown feature and a hardware error is detected, the system displays an explanatory message on the startup screen. The following truncated sample output shows the startup screen if a stand-alone switch is shut down as a result of the hardware recovery configuration:

```
All switch ports have been shut down.  
Use the "clear sys-recovery-level" command to restore all ports.
```

```
! SummitX450-24x.1 #
```

When an exclamation point (!) appears in front of the command line prompt, it indicates that the entire stand-alone switch is shut down as a result of your hardware recovery configuration and a switch error.

Displaying the Hardware Recovery Setting

To display the hardware recovery setting, use the following command:

```
show switch
```

If you change the hardware recovery setting from the default (reset) to either none (ignore) or shutdown, the switch expands the Recovery Mode output to include a description of the hardware recovery mode. If you keep the default behavior or return to reset, the Recovery Mode output lists only the software recovery setting.

The following truncated output from a Summit series switch displays the software recovery and hardware recovery settings (displayed as `Recovery Mode`):

```
SysName:          TechPubs Lab
SysLocation:
SysContact:       support@extremenetworks.com, +1 888 257 3000
System MAC:       00:04:96:1F:A5:71
Recovery Mode:    All
System Watchdog:  Enabled
```

To see the output of `show switch` command for a particular node other than the master, you should log into that node and run the `show switch` command.

If you configure the hardware recovery setting to none, the output displays “Ignore” to indicate that no corrective actions will occur on the switch. “Ignore” appears only if you configure the hardware recovery setting to none.

If you configure the hardware recovery setting to shut down, the output displays “Shutdown” to indicate that the switch will shut down if fault detection occurs. “Shutdown” appears only if you

configure the hardware recovery setting to shut down.

If you configure the hardware recovery setting to reset, the output only displays the software recovery mode.

Clearing the Shutdown State

If you configure the switch to shut down upon detecting a hardware fault, and the switch enters the shutdown state, you must explicitly clear the shutdown state and reboot for the switch to become functional. To clear the shutdown state, use the following command:

```
clear sys-recovery-level
```

On a SummitStack, use the command:

```
clear sys-recovery-level slot <slot>
```

The switch prompts you to confirm this action. The following is a sample confirmation message:

```
Are you sure you want to clear sys-recovery-level? (y/n)
```

Enter `y` to confirm this action and clear the shutdown state. Enter `n` or press [Enter] to cancel this action.

After you clear the shutdown state, use the `reboot` command to bring the switch and ports back online. After you use the reboot command, the switch is operational.

Configuring Module Recovery—Modular Switches Only

You can configure the MSMs/MMs or I/O modules installed in BlackDiamond X8 and 8800 series switches to take no action, take ports offline in response to errors, automatically reset, shutdown, or if dual MSMs/MMs are installed failover to the other MSM/MM if the switch detects a hardware fault. This enhanced level of recovery detects faults in the ASICs as well as packet buses.

To configure module recovery, use the following command:

```
configure sys-recovery-level slot [all | <slot_number>] [none | reset | shutdown]
```

Where the following is true:

- `none`—Configures the MSM/MM or I/O module to maintain its current state regardless of the detected fault. The offending MSM/MM or I/O module is not reset. ExtremeXOS logs fault and error messages to the syslog and notifies you that the errors are ignored. This does not guarantee that the module remains operational; however, the switch does not reboot the module.



NOTE

When the `sys-recovery-level` is set to `none`, running `msm-failover` does not reboot the current MSM. However, for Black Diamond X8 and 8800 series switches, the MSM/MM modules are rebooted.

- `reset`—Configures the offending MSM/MM or I/O module to reset upon fault detection. ExtremeXOS logs fault, error, system reset, and system reboot messages to the syslog.
- `shutdown`—Configures the switch to shut down all slots/modules configured for shutdown upon fault detection. On the modules configured for shutdown, all ports in the slot are taken offline in response to the reported errors; however, the MSMs/MMs remain operational for debugging purposes only. You must save the configuration, using the `save configuration` command, for it to

take effect. ExtremeXOS logs fault, error, system reset, system reboot, and system shutdown messages to the syslog.

The default setting is `reset`.

Depending on your configuration, the switch resets the offending MSM/MM or I/O module if a hardware fault detection occurs. An offending MSM/MM is reset any number of times and is not permanently taken offline. On BlackDiamond X8 and 8800 series switches, an offending I/O module is reset a maximum of five times. After the maximum number of resets, the I/O module is permanently taken offline. For more information, see [“Module Recovery Actions—BlackDiamond 8800 Series Switches and BlackDiamond X8 Series Switches Only”](#) on page 478.

You can configure how ExtremeXOS handles a detected fault based on the configuration of the `configure sys-recovery-level slot [all | <slot_number>] [none | reset | shutdown]` command.

To configure how ExtremeXOS handles faults, use the `configure sys-health-check all level [normal | strict]` command. For detailed information about this command, see the *ExtremeXOS Command Reference Guide*.

To view the system health check settings on the switch, use the `show switch` command as described in [“Displaying the System Health Check Setting—All Platforms”](#) on page 471.

Confirmation Messages Displayed

If you configure the hardware recovery setting to either none (ignore) or shutdown, the switch prompts you to confirm this action. The following is a sample shutdown message:

```
Are you sure you want to shutdown on errors? (y/n)
```

Enter `y` to confirm this action and configure the hardware recovery level. Enter `n` or press [Enter] to cancel this action.

Understanding the Shut Down Recovery Mode

You can configure the switch to shut down one or more I/O modules upon fault detection by specifying the `shutdown` option. If you configure one or more slots to shut down and the switch detects a hardware fault, all ports in all of the configured shut down slots are taken offline in response to the reported errors. (MSMs/MMs are available for debugging purposes only.)



NOTE

On the BlackDiamond 8800 and BlackDiamond X8 chassis, you must save the configuration before the “shutdown” configuration takes effect.

The affected I/O module remains in the shutdown state across additional reboots or power cycles until you explicitly clear the shutdown state. If a module enters the shutdown state, the module actually reboots and the `show slot` command displays the state of the slot as Initialized; however, the ports are shut down and taken offline. For more information about clearing the shutdown state, see [“Clearing the Shutdown State”](#) on page 481.

Messages Displayed at the Startup Screen

If you configure the shutdown feature and a hardware error is detected, the system displays an explanatory message on the startup screen. The following truncated sample output shows the startup screen if any of the slots in a modular switch are shut down as a result of the system recovery configuration:

```
The I/O modules in the following slots are shut down: 1,3
Use the "clear sys-recovery-level" command to restore I/O modules
```

```
! BD-8810.1 #
```

When an exclamation point (!) appears in front of the command line prompt, it indicates that one or more slots shut down as a result of your system recovery configuration and a switch error.

Module Recovery Actions—BlackDiamond 8800 Series Switches and BlackDiamond X8 Series Switches Only

Table 63 describes the actions module recovery takes based on your module recovery setting. For example, if you configure a module recovery setting of `reset` for an I/O module, the module is reset a maximum of five times before it is taken permanently offline.

From left to right, the columns display the following information:

- **Module Recovery Setting**—This is the parameter used by the `configure sys-recovery-level slot` command to distinguish the module recovery behavior.
- **Hardware**—This indicates the hardware that you may have installed in your switch.
- **Action Taken**—This describes the action the hardware takes based on the module recovery setting.

Table 63: Module Recovery Actions for the BlackDiamond X8 and 8800 Series Switches

Module Recovery Setting	Hardware	Action Taken
none	Single MSM	The MSM remains powered on in its current state. This does not guarantee that the module remains operational; however, the switch does not reboot the module.
	Dual MSM	The MSM remains powered on in its current state. This does not guarantee that the module remains operational; however, the switch does not reboot the module.
	I/O Module	The I/O module remains powered on in its current state. The switch sends error messages to the log and notifies you that the errors are ignored. This does not guarantee that the module remains operational; however, the switch does not reboot the module.
reset	Single MSM	Resets the MSM.
	Dual MSM	Resets the primary MSM and fails over to the backup MSM.
	I/O Module	Resets the I/O module a maximum of five times. After the fifth time, the I/O module is permanently taken offline.
shutdown		

Table 63: Module Recovery Actions for the BlackDiamond X8 and 8800 Series Switches

Module Recovery Setting	Hardware	Action Taken
	Single MSM	The MSM is available for debugging purposes only (the I/O ports also go down); however, you must clear the shutdown state using the <code>clear sys-recovery-level</code> command for the MSM to become operational. After you clear the shutdown state, you must reboot the switch. For more information see, “Clearing the Shutdown State” on page 481 .
	Dual MSM	The MSMs are available for debugging purposes only (the I/O ports also go down); however, you must clear the shutdown state using the <code>clear sys-recovery-level</code> command for the MSM to become operational. After you clear the shutdown state, you must reboot the switch. For more information see, “Clearing the Shutdown State” on page 481 .
	I/O Module	Reboots the I/O module. When the module comes up, the ports remain inactive because you must clear the shutdown state using the <code>clear sys-recovery-level</code> command for the I/O module to become operational. After you clear the shutdown state, you must reset each affected I/O module or reboot the switch. For more information see, “Clearing the Shutdown State” on page 481 .

Displaying the Module Recovery Setting

To display the module recovery setting, use the following command:

```
show slot
```

The `show slot` output includes the shutdown configuration. If you configure the module recovery setting to shut down, the output displays an “E” flag that indicates any errors detected on the slot disables all ports on the slot. The “E” flag appears only if you configure the module recovery setting to shut down.



NOTE

If you configure one or more slots for shut down and the switch detects a hardware fault on one of those slots, all of the configured slots enter the shutdown state and remain in that state until explicitly cleared.

If you configure the module recovery setting to none, the output displays an “e” flag that indicates no corrective actions will occur for the specified MSM/MM or I/O module. The “e” flag appears only if you configure the module recovery setting to none.

Here's an example from a BlackDiamond 8810 with slot 2 configured for “shutdown”:

Slots	Type	Configured	State	Ports	Flags
Slot-1	8900-G96T-c	8900-G96T-c	Operational	96	MB
Slot-2	8900-10G24X-c	8900-10G24X-c	Operational	24	MB E
Slot-3	8900-40G6X-xm	8900-40G6X-xm	Operational	24	MB
Slot-4	G48Xc	G48Xc	Operational	48	MB
Slot-5	G8Xc	G8Xc	Operational	8	MB
Slot-6			Empty	0	
Slot-7	G48Te2 (PoE)	G48Te2 (PoE)	Operational	48	MB
Slot-8	G48Tc	G48Tc	Operational	48	MB
Slot-9	10G4Xc	10G4Xc	Operational	4	MB
Slot-10			Empty	0	
MSM-A	8900-MSM128		Operational	0	
MSM-B	8900-MSM128		Operational	0	

Flags : M - Backplane link to Master is Active
 B - Backplane link to Backup is also Active
 D - Slot Disabled
 I - Insufficient Power (refer to "show power budget")
 e - Errors on slot will be ignored (no corrective action initiated)
 E - Errors on slot will disable all ports on slot



NOTE

In ExtremeXOS 11.4 and earlier, if you configure the module recovery setting to none, the output displays an “e” flag that indicates no corrective actions will occur for the specified MSM/MM or I/O module. The “e” flag appears only if you configure the module recovery setting to none.

Displaying Detailed Module Recovery Information

To display the module recovery setting for a specific port on a module, including the current recovery mode, use the following command:

```
show slot <slot>
```

In addition to the information displayed with `show slot`, this command displays the module recovery setting configured on the slot. The following truncated output displays the module recovery setting (displayed as `Recovery Mode`) for the specified slot:

Here is an example of `show slot` using the same slot 2 as the example above:

```
Slot-2 information:
  State:                Operational
  Download %:           100
  Flags:                MB E
  Restart count:        0 (limit 5)
  Serial number:        800264-00-01 0907G-00166
  Hw Module Type:       8900-10G24X-c
  SW Version:           15.2.0.26
  SW Build:              v1520b26
  Configured Type:      8900-10G24X-c
  Ports available:      24
  Recovery Mode:         Shutdown
  Debug Data:           Peer=Operational
```

Flags : M - Backplane link to Master is Active
 B - Backplane link to Backup is also Active
 D - Slot Disabled
 I - Insufficient Power (refer to "show power budget")
 e - Errors on slot will be ignored (no corrective action initiated)
 E - Errors on slot will disable all ports on slot

Clearing the Shutdown State

If you configure one or more modules to shut down upon detecting a hardware fault, and the switch enters the shutdown state, you must explicitly clear the shutdown state and reset the affected modules for the switch to become functional. To clear the shutdown state, use the following command:

```
clear sys-recovery-level
```

The switch prompts you to confirm this action. The following is a sample confirmation message:

```
Are you sure you want to clear sys-recovery-level? (y/n)
```

Enter `y` to confirm this action and clear the shutdown state. Enter `n` or press [Enter] to cancel this action.

After using the `clear sys-recovery-level` command, you must reset each affected module.

If you configured only a few I/O modules to shutdown, reset each affected I/O module as follows:

- 1 Disable the slot using the `disable slot <slot>` command.
- 2 Re-enable the slot using the `enable slot <slot>` command.



NOTE

You must complete this procedure for each module that enters the shutdown state.

If you configured all I/O modules or one or more MSM/MMs to shutdown, use the `reboot` command to reboot the switch and reset all affected I/O modules.

After you clear the shutdown state and reset the affected module, each port is brought offline and then back online before the module and the entire system is operational.

Troubleshooting Module Failures

If you experience an I/O module failure, use the following troubleshooting methods when you can bring the switch offline to solve or learn more about the problem:

- Restarting the I/O module—Use the `disable slot <slot>` command followed by the `enable slot <slot>` command to restart the offending I/O module. By issuing these commands, the I/O module and its associated fail counter is reset. If the module does not restart, or you continue to experience I/O module failure, contact Extreme Networks Technical Support.
- Running diagnostics—Use the `run diagnostics normal <slot>` command to run diagnostics on the offending I/O module to ensure that you are not experiencing a hardware issue. If the module continues to enter the failed state, please contact Extreme Networks Technical Support. For more information about switch diagnostics, see [“Performing Switch Diagnostics” on page 462](#).

If you experience an MSM/MM failure, contact Extreme Networks Technical Support.

Using ELSM

Extreme Link Status Monitoring (ELSM) is an Extreme Networks proprietary protocol that monitors network health by detecting CPU and remote link failures. ELSM is available only on Extreme Networks devices and operates on a point-to-point basis. You configure ELSM on the ports that connect to other network devices and on both sides of the peer connection.

This section describes the following topics:

- [About ELSM on page 482](#)
- [ELSM Hello Messages on page 482](#)
- [ELSM Port States on page 484](#)
- [Link States on page 484](#)
- [ELSM Link States on page 485](#)
- [ELSM Timers on page 486](#)
- [Configuring ELSM on a Switch on page 487](#)
- [Displaying ELSM Information on page 489](#)
- [Using ELSM with Layer 2 Control Protocols on page 491](#)
- [ELSM Configuration Example on page 493](#)

About ELSM

ELSM monitors network health by exchanging various hello messages between two ELSM peers. ELSM uses an open-ended protocol, which means that an ELSM-enabled port expects to send and receive hello messages from its peer. The Layer 2 connection between ports determines the peer connection. Peers can be either directly connected or separated by one or more hubs. If there is a direct connection between peers, they are considered neighbors.

If ELSM detects a failure, the ELSM-enabled port responds by blocking traffic on that port. For example, if a peer stops receiving messages from its peer, ELSM brings down that connection by blocking all incoming and outgoing data traffic on the port and notifying applications that the link is down.

In some situations, a software or hardware fault may prevent the CPU from transmitting or receiving packets, thereby leading to the sudden failure of the CPU. If the CPU is unable to process or send packets, ELSM isolates the connections to the faulty switch from the rest of the network. If the switch fabric sends packets during a CPU failure, the switch may appear healthy when it is not. For example, if hardware forwarding is active and software forwarding experiences a failure, traffic forwarding may continue. Such failures can trigger control protocols such as Extreme Standby Router Protocol (ESRP) or Ethernet Automatic Protection Switching (EAPS) to select different devices to resume forwarding. This recovery action, combined with the CPU failure, can lead to loops in a Layer 2 network.

Configuring ELSM on Extreme Networks devices running ExtremeXOS is backward compatible with Extreme Networks devices running ExtremeWare.

ELSM Hello Messages

ELSM uses two types of hello messages to communicate the health of the network to other ELSM ports. The following describes the hello messages:

- **Hello+** — The ELSM-enabled port receives a hello message from its peer and no problem is detected.

- Hello- — The ELSM-enabled port has not received a hello message from its peer.

In addition to the ELSM port states described in the next section, ELSM has hello transmit states. The hello transmit states display the current state of transmitted ELSM hello messages and can be one of the following:

- HelloRx(+)—The ELSM-enabled port is up and receives Hello+ messages from its peer. The port remains in the HelloRx+ state and restarts the HelloRx timer each time it receives a Hello+ message. If the HelloRx timer expires, the hello transmit state enters HelloRx(-). The HelloRx timer is $6 * \text{hello timer}$, which by default is 6 seconds.
- HelloRx(-)—The ELSM-enabled port either transitions from the initial ELSM state or is up but has not received hello messages because there is a problem with the link or the peer is missing.

For information about displaying ELSM hello messages and hello transmit states, see [“Displaying ELSM Information” on page 489](#).

ELSM Port States

Each ELSM-enabled port exists in one of the following states:

- **Up**—Indicates a healthy remote system and this port is receiving Hello+ messages from its peer. If an ELSM-enabled port enters the Up state, the up timer begins. Each time the port receives a Hello+ message from its peer, the up timer restarts and the port remains in the Up state. The up timer is 6 * hello timer, which by default is 6 seconds.
- **Down**—Indicates that the port is down, blocked, or has not received Hello+ messages from its peer. If an ELSM-enabled port does not receive a hello message from its peer before the up timer expires, the port transitions to the Down state. When ELSM is down, data packets are neither forwarded nor transmitted out of that port.
- **Down-Wait**—Indicates a transitional state. If the port enters the Down state and later receives a Hello+ message from its peer, the port enters the Down-Wait state. If the number of Hello+ messages received is greater than or equal to the hold threshold (by default 2 messages), the port transitions to the Up state. If the number of Hello+ messages received is less than the hold threshold, the port enters the Down state.
- **Down-Stuck**—Indicates that the port is down and requires user intervention. If the port repeatedly flaps between the Up and Down states, the port enters the Down-Stuck state. Depending on your configuration, there are two ways for a port to transition out of this state: By default, automatic restart is enabled, and the port automatically transitions out of this state. For more information, see the `enable elsm ports <portlist> auto-restart` command. If you disabled automatic restart, and the port enters the Down-Stuck state, you can clear the stuck state and enter the Down state by using one of the following commands:

- `clear elsm ports <portlist> auto-restart`
- `enable elsm ports <portlist> auto-restart`



NOTE

If you reboot the peer switch, its ELSM-enabled peer port may enter the Down-Stuck state. If this occurs, clear the stuck state using one of the following commands: `clear elsm ports <portlist> auto-restart` or `enable elsm ports <portlist> auto-restart`.

For information about displaying ELSM port states, see “[Displaying ELSM Information](#)” on page 489.

Link States

The state of the link between ELSM-enabled (peer) ports is known as the link state. The link state can be one of the following:

- **Ready**—Indicates that the port is enabled but there is no physical link
- **Active**—Indicates that the port is enabled and the physical link is up

To view the state of the link between the peer ports, use the following commands:

- `show elsm ports <all | portlist>`
- `show ports {<port_list>} information {detail}`

If you use the `show elsm ports <all | portlist>` command, the `Link State` row displays link state information.

If you use the `show ports {<port_list> information` command, the `Link State` column displays link state information.

If you use the `show ports {<port_list> information` command and specify the `detail` option, the `ELSM Link State` row displays ELSM link state information. For more information, see [“ELSM Link States” on page 485](#).

For more information about these `show` commands, see [“Displaying ELSM Information” on page 489](#).

ELSM Link States

The state of the ELSM logical link is known as the ELSM link state. The ELSM link state can be one of the following:

- ELSM is enabled and the ELSM peer ports are up and communicating
- ELSM is enabled but the ELSM peer ports are not up or communicating
- ELSM is disabled

To view the current state of ELSM on the switch, use the following commands:

- `show elsm`
- `show elsm ports <all | portlist>`
- `show ports {<port_list> information {detail}}`

If you use the `show elsm` commands, the following terms display the ELSM link state:

- **Up**—Indicates that ELSM is enabled and the ELSM peer ports are up and communicating; the ELSM link state is up. In the up state, the ELSM-enabled port sends and receives hello messages from its peer.
- **Down**—Indicates that ELSM is enabled, but the ELSM peers are not communicating; the ELSM link state is down. In the down state, ELSM transitions the peer port on this device to the down state. ELSM blocks all incoming and outgoing switching traffic and all control traffic except ELSM PDUs.

If ELSM is disabled, the switch does not display any information.

If you use the `show ports {<port_list> information {detail}}` command, the following columns display the current state of ELSM on the switch:

- **Flags**
 - **L**—Indicates that ELSM is enabled on the switch
 - **-**—Indicates that ELSM is disabled on the switch
- **ELSM**
 - **up**—Indicates that ELSM is enabled and the ELSM peer ports are up and communicating; the ELSM link state is up. In the up state, the ELSM-enabled port sends and receives hello messages from its peer.
 - **dn**—Indicates that ELSM is enabled, but the ELSM peers are not communicating; the ELSM link state is down. In the down state, ELSM transitions the peer port on this device to the down state. ELSM blocks all incoming and outgoing switching traffic and all control traffic except ELSM PDUs.
 - **-**—Indicates that ELSM is disabled on the switch.

If you specify the optional `detail` parameter, the following ELSM output is called out in written explanations versus displayed in a tabular format:

- ELSM Link State (displayed only if ELSM is enabled on the switch)
 - Up—Indicates that ELSM is enabled and the ELSM peer ports are up and communicating; the ELSM link state is up. In the up state, the ELSM-enabled port sends and receives hello messages from its peer.
 - Down—Indicates that ELSM is enabled, but the ELSM peers are not communicating; the ELSM link state is down. In the down state, ELSM transitions the peer port on this device to the down state. ELSM blocks all incoming and outgoing switching traffic and all control traffic except ELSM PDUs.
- ELSM
 - Enabled—Indicates that ELSM is enabled on the switch
 - Disabled—Indicates that ELSM is disabled on the switch

For more information about these `show` commands, see [“Displaying ELSM Information” on page 489](#).

ELSM Timers

To determine whether there is a CPU or link failure, ELSM requires timer expiration between the ELSM peers. Depending on the health of the network, the port enters different states when the timers expire. For more information about the ELSM port states, see [“ELSM Port States” on page 484](#).

[Table 64](#) describes the ELSM timers. Only the hello timer is user-configurable; all other timers are derived from the hello timer. This means that when you modify the hello timer, you also modify the values for down, up, and HelloRx timers.

Table 64: ELSM Timers

Timer	Description
Hello	The ELSM hello timer is the only user-configurable timer and specifies the time in seconds between consecutive hello messages. The default value is 1 second, and the range is 100 milliseconds to 255 seconds.
Down	<p>The ELSM down timer specifies the time it takes the ELSM port to cycle through the following states:</p> <ul style="list-style-type: none"> • Down—Indicates that the port is down, blocked, or has not received Hello+ messages from its peer. • Down-Wait—Indicates a transitional state. • Up—Indicates a healthy remote system and this port is receiving Hello+ messages from its peer. <p>By default, the down timer is $(2 + \text{hold threshold}) * \text{hello timer}$, which is 4 seconds. If the hold threshold is set to 2 and the hello timer is set to 1 second, it takes 4 seconds for the ELSM port receiving messages to cycle through the states.</p> <p>After the down timer expires, the port checks the number of Hello+ messages against the hold threshold. If the number of Hello+ messages received is greater than or equal to the configured hold threshold, the ELSM receive port moves from the Down-Wait state to the Up state.</p> <p>If the number of Hello+ messages received is less than the configured hold threshold, the ELSM receive port moves from the Down-Wait state back to the Down state and begins the process again.</p>

Table 64: ELSM Timers (Continued)

Timer	Description
Up	The ELSM up timer begins when the ELSM-enabled port enters the UP state. Each time the port receives a Hello+ message, the timer restarts. Up timer is the UpTimer threshold * hello timer. It is configurable and the range is 3 to 60 seconds. By default, the UpTimer threshold is 6. Therefore, the default up timer is 6 seconds (6*1).
HelloRx	The ELSM HelloRx timer specifies the time in which a hello message is expected. If the port does not receive a hello message from its peer, there is the possibility of a CPU or link failure. By default the HelloRx timer 6 * hello timer, which is 6 seconds.

Configuring ELSM on a Switch

This section describes the commands used to configure ELSM on the switch and contains the following topics:

- [Enabling ELSM on page 487](#)
- [Configuring the ELSM Hello Timer on page 488](#)
- [Configuring the ELSM Hold Threshold on page 488](#)
- [Configuring Automatic Restart on page 488](#)
- [Disabling ELSM on page 489](#)



NOTE

Extreme Networks does not recommend enabling the Link Aggregation Control Protocol (LACP) and ELSM on the same port. For more information about LACP, see [Chapter 5, “Configuring Slots and Ports on a Switch.”](#)



NOTE

ELSM and mirroring are mutually exclusive. You can enable either ELSM, or mirroring, but not both.

Enabling ELSM

ELSM works between two connected ports (peers), and each ELSM instance is based on a single port. The Layer 2 connection between the ports determines the peer. You can have a direct connection between the peers or hubs that separate peer ports. In the first instance, the peers are also considered neighbors. In the second instance, the peer is not considered a neighbor.

To enable ELSM on one or more ports, use the following command:

```
enable elsm ports <portlist>
```

When you enable ELSM on a port, ELSM immediately blocks the port and it enters the Down state. When the port detects an ELSM-enabled peer, the peer ports exchange ELSM hello messages. At this point, the ports enter the transitional Down-Wait state. If the port receives Hello+ messages from its peer and does not detect a problem, the peers enter the Up state. If a peer detects a problem or there is no peer port configured, the port enters the Down state.

For more information about the types of ELSM hello messages, see [“ELSM Hello Messages” on page 482](#). For information about configuring the ELSM hello timer, see the next section.

Configuring the ELSM Hello Timer

The ELSM hello timer is the only user-configurable timer and specifies the time in seconds between consecutive hello messages. The default value is 1 second, and the range is 1 to 128 seconds. Although other timers rely on the hold timer for their values, you do not explicitly configure the down, up, or HelloRx timers. If you modify the hello timer on one port, Extreme Networks recommends that you use the same hello timer value on its peer port.

A high hello timer value can increase the time it takes for the ELSM-enabled port to enter the Up state. The down timer is $(2 + \text{hold threshold}) * \text{hello timer}$. Assuming the default value of 2 for the hold threshold, configuring a hello timer of 128 seconds creates a down timer of $(2 + 2) 128$, or 512 seconds. In this scenario it would take 512 seconds for the port to transition from the Down to the Up state.

To configure the ELSM hello timer, use the following command:

```
configure elsm ports <portlist> hellotime <hello_time>
```

Configuring the ELSM Hold Threshold

The ELSM hold threshold determines the number of Hello+ messages the ELSM peer port must receive to transition from the Down-Wait state to the Up state. For example, a threshold of 1 means the ELSM port must receive at least one Hello+ message to transition from the Down-Wait state to the Up state. The default is two messages, and the range is one to three messages.

After the down timer expires, the port checks the number of Hello+ messages against the hold threshold. If the number of Hello+ messages received is greater than or equal to the configured hold threshold, the ELSM receive port moves from the Down-Wait state to the Up state.

If the number of Hello+ messages received is less than the configured hold threshold, the ELSM receive port moves from the Down-Wait state back to the Down state and begins the process again.

If you modify the hold threshold on one port, Extreme Networks recommends that you use the same hold threshold value on its peer port.

You configure the hold threshold on a per-port basis, not on a per-switch basis.

To configure the ELSM hold threshold, use the following command:

```
configure elsm ports <portlist> hold-threshold <hold_threshold>
```

Configuring Automatic Restart

You must explicitly configure automatic restart on each ELSM-enabled port; this is not a global configuration.

By default, ELSM automatic restart is enabled. If an ELSM-enabled port goes down, ELSM bypasses the Down-Stuck state and automatically transitions the down port to the Down state, regardless of the number of times the port goes up and down. For information about the port states, see [“ELSM Port States” on page 484](#).

If you disable ELSM automatic restart, the ELSM-enabled port can transition between the following states multiple times: Up, Down, and Down-Wait. When the number of state transitions is greater than or equal to the sticky threshold, the port enters the Down-Stuck state. The ELSM sticky threshold specifies the number of times a port can transition between the Up and Down states. The sticky threshold is not user-configurable and has a default value of 1. That means a port can transition only

one time from the Up state to the Down state. If the port attempts a subsequent transition from the Up state to the Down state, the port enters the Down-Stuck state.

If the port enters the Down-Stuck state, you can clear the stuck state and enter the Down state by using one of the following commands:

```
clear elsm ports <portlist> auto-restart
enable elsm ports <portlist> auto-restart
```

If you use the `enable elsm ports <portlist> auto-restart` command, automatic restart is always enabled; you do not have to use the `clear elsm ports <portlist> auto-restart` command to clear the stuck state.

Disabling Automatic Restart. To disable automatic restart, use the following command:

```
disable elsm ports <portlist> auto-restart
```

Extreme Networks recommends that you use the same automatic restart configuration on each peer port.

Re-Enabling Automatic Restart. To re-enable automatic restart, use the following command:

```
enable elsm ports <portlist> auto-restart
```

Extreme Networks recommends that you use the same automatic restart configuration on each peer port.

Re-Setting the Sticky Threshold. The following user events clear or re-set the sticky threshold:

- Enabling automatic restart on the port using the following command:
`enable elsm ports <portlist> auto-restart`
- Clearing the port that is in the Down-Stuck state using the following command:
`clear elsm ports <portlist> auto-restart`
- Disabling and re-enabling the port using the following commands:
`disable ports [<port_list | all]`
`enable ports [<port_list | all]`
- Disabling ELSM on the port using the following command:
`disable elsm ports <portlist>`

Disabling ELSM

To disable ELSM on one or more ports, use the following command:

```
disable elsm ports <portlist>
```

When you disable ELSM on the specified ports, the ports no longer send ELSM hello messages to their peers and no longer maintain ELSM states.

Displaying ELSM Information

To display summary information for all of the ELSM-enabled ports on the switch, use the following command:

```
show elsm
```

This command displays in a tabular format the operational state of ELSM on the configured ports.

If ports are configured for ELSM (ELSM is enabled), the switch displays the following information:

- Port—The port number of the ELSM-enabled port.
- ELSM State—The current state of ELSM on the port.
For information about the port states, see [“ELSM Port States” on page 484](#).
- Hello time—The current value of the hello timer, which by default is 1 second.
For information about configuring the hello timer, see [“Configuring the ELSM Hello Timer” on page 488](#).

If no ports are configured for ELSM (ELSM is disabled), the switch does not display any information.

To display detailed information for one or more ELSM-enabled ports on the switch, use the following command:

```
show elsm ports <all | portlist>
```

In addition to the port, ELSM state, and hello timer information, this command displays in a tabular format the following:

- Link State—The state of the link between ELSM-enabled ports.
For information about the link states, see [“Link States” on page 484](#).
- ELSM Link State—The current state of the ELSM logical link on the switch.
For more information, see [“ELSM Link States” on page 485](#).
- Hello Transmit State—The current state of ELSM hello messages being transmitted.
- Hold Threshold—The number of Hello+ messages required by the ELSM-enabled port to transition from the Down-Wait state to the Up state within the hold threshold.
- UpTimer Threshold—The number of hello times that span without receiving Hello+ packets before a port changes its ELSM state from Up to Down.
- Auto Restart—The current state of ELSM automatic restart on the port.
- Sticky Threshold—The number of times a port can transition between the Up and Down states. The sticky threshold is not user-configurable and has a default value of 1.
- Sticky Threshold Counter—The number of times the port transitions from the Up state to the Down state.
- Down Timeout—The actual waiting time (msecs or secs) before a port changes its ELSM state from Down to Up after receiving the first Hello+ packet. It is equal to [Hello Time * (Hold Threshold+2)].
- Up Timeout—The actual waiting time (msecs or secs) before a port changes its ELSM state from Up to Down after receiving the last Hello+ packets. It is equal to [Hello Time * UpTimer Threshold].

The remaining output displays counter information. Use the counter information to determine the health of the ELSM peers and how often ELSM has gone up or down. The counters are cumulative.

- Rx Hello+—The number of Hello+ messages received by the port.
- Rx Hello- —The number of Hello- messages received by the port.
- Tx Hello+—The number of Hello+ messages sent by the port.
- Tx Hello- —The number of Hello- messages sent by the port.
- ELSM Up/Down Count—The number of times ELSM has been up or down.

To display summary port information in a tabular format for one or more ELSM-enabled ports, use the following command:

```
show ports {<port_list>} information {detail}
```

This command displays the following ELSM information:

- Flags
 - L—ELSM is enabled on the switch
 - - —ELSM is disabled on the switch
- ELSM
 - up—ELSM is enabled and the ELSM link state is up.
 - dn—ELSM is enabled and the ELSM link state is down.
 - - —ELSM is disabled on the switch.

For more information, see [“ELSM Link States” on page 485](#).

To display summary port information called out in written explanations versus displayed in a tabular format, use the following command and specify the optional `detail` parameter:

```
show ports {<port_list>} information detail
```

This command displays the following ELSM information:

- ELSM Link State (displayed only if ELSM is enabled on the switch).
 - Up—ELSM is enabled and the ELSM link state is up.
 - Down—ELSM is enabled and the ELSM link state is down.

For more information, see [“ELSM Link States” on page 485](#).
- Link State—The state of the link between ELSM-enabled ports.

For information about the link states, see [“Link States” on page 484](#).
- ELSM
 - Enabled—ELSM is enabled on the switch
 - Disabled—ELSM is disabled on the switch

Clearing ELSM Counters

Before clearing the ELSM counters, you should use the `show elsm` and `show elsm ports` commands to view the ELSM information. To clear only the ELSM-related counters gathered by the switch, use the following command:

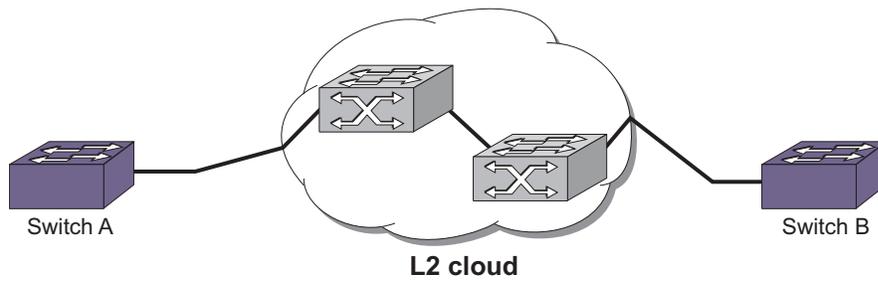
```
clear elsm {ports <portlist>} counters
```

You can also use the `clear counters` command, which clears all of the counters on the device, including those associated with ELSM.

Using ELSM with Layer 2 Control Protocols

You can use ELSM with Layer 2 control protocols such as STP, ESRP, EAPS, and so on to improve the recovery of Layer 2 loops in the network. ELSM detects remote link failures if the established link is through a Layer 2 transport cloud and the ELSM endpoints traverse the Layer 2 cloud in a point-to-point fashion, as shown in [Figure 51](#).

Figure 51: ELSM Through a Layer 2 Cloud



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A sudden failure of the switch CPU may cause the hardware to continue forwarding traffic. For example, ESRP may select a second device for forwarding traffic thereby creating a Layer 2 loop in the network. If you configure ELSM and the CPU fails, ELSM closes the connection to the faulty device to prevent a loop.

ELSM Configuration Example

The following example configures ELSM on two ports connected directly to each other and assumes the following:



NOTE

In the following sample configurations, any lines marked (Default) represent default settings and do not need to be explicitly configured.

Switch A Configuration

- ELSM-enabled port—Port 1
- Hello timer—2 seconds
- Hello threshold—2 hello messages

```
enable elsm ports 1
configure elsm ports 1 hellotime 2
configure elsm ports 1 hello-threshold 2 (Default)
```

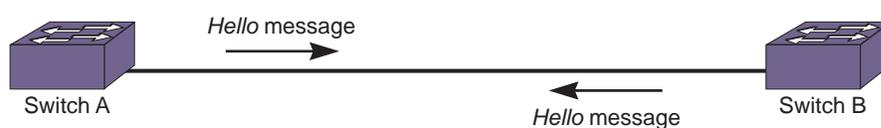
Switch B Configuration

- ELSM-enabled port—Slot 2, port 1
- Hello timer—2 seconds
- Hello threshold—2 hello messages

```
enable elsm ports 2:1
configure elsm ports 2:1 hellotime 2
configure elsm ports 2:1 hello-threshold 2 (Default)
```

After you enable ELSM on the ports, the peers exchange hello messages with each other as displayed in [Figure 52](#).

Figure 52: Extreme Networks Switches with ELSM-Enabled Ports Exchanging Hello Messages



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Viewing Fan Information

You can view detailed information about the fans installed in your switch. Depending on your switch model, different information may be displayed.

To view detailed information about the health of the fans, use the following command:

```
show fans
```

The switch collects and displays the following fan information:

- **State**—The current state of the fan. Options are:
 - **Empty:** There is no fan installed.
 - **Failed:** The fan failed.
 - **Operational:** The fan is installed and working normally.
- **NumFan**—The number of fans in the fan tray.
- **Fan Name**, displayed as Fan-1, Fan-2, and so on (modular switches also include a description of the location, for example, Upper or Upper-Right)—Specifies the individual state for each fan in a fan tray and its current speed in revolutions per minute (rpm).

On modular switches, the output also includes the following information:

- **PartInfo**—Information about the fan tray, including the:
 - **Serial number**—A collection of numbers and letters, that make up the serial number of the fan. This is the first series of numbers and letters in the display.
 - **Part number**—A collection of numbers and letters, that make up the part number of the fan. This is the second series of numbers and letters in the display.
- **Revision**—The revision number of the fan.
- **Odometer**—Specifies the power-on date and how long the fan tray has been operating since it was first powered-on.

Viewing the System Temperature

Depending on your switch model, you can view the temperature in Celsius of the I/O modules, management modules, power controllers, power supplies, and fan trays installed in your switch. In addition, depending on the software version running on your switch, additional or different temperature information might be displayed.

This section describes the following topics:

- [System Temperature Output on page 495](#)
- [Power Supply Temperature—Modular Switches Only on page 496](#)

To view the system temperature, use the following command:

```
show temperature
```

System Temperature Output

Modular Switches and SummitStack Only

On a modular switch, the output includes the current temperature and operating status of the I/O modules, management modules, and power controllers. On a SummitStack, the output includes the current temperature and operating status of all active nodes and their option cards (if any).

The following output shows a sample display of the current temperature and operating status of the installed modules and power controllers:

```
BD-8810.7 # show temperature
Field Replaceable Units          Temp (C)   Status   Min  Normal  Max
-----
Slot-1      : 8900-10G24X-c         37.00    Normal  -10   0-55   65
Slot-2      : 10G8Xc                33.00    Normal  -10   0-50   60
Slot-3      :
Slot-4      :
Slot-5      : G8Xc                 31.50    Normal  -10   0-50   60
Slot-6      :
Slot-7      :
Slot-8      : 10G4Xa                26.00    Normal  -10   0-50   60
Slot-9      :
Slot-10     : 8900-G96T-c            38.50    Normal  -10   0-55   65
MSM-A       : 8900-MSM128           31.00    Normal  -10   0-55   65
MSM-B       : 8900-MSM128           31.00    Normal  -10   0-55   65
PSUCTRL-1   :                          34.04    Normal  -10   0-50   60
PSUCTRL-2   :                          35.79    Normal  -10   0-50   60
```

The switch monitors the temperature of each component and generates a warning if the temperature exceeds the normal operating range. If the temperature exceeds the minimum/maximum limits, the switch shuts down the overheated module.

The following output shows a sample display from a SummitStack.

```
Slot-3 Stack.1 # show temperature
Field Replaceable Units          Temp (C)   Status   Min  Normal  Max
-----
Slot-1      :
Slot-2      : X250e-48t             34.50    Normal  -10   0-54   59
Slot-3      : X450a-48t             36.50    Normal  -10   0-66   67
Slot-4      :
Slot-5      :
Slot-6      :
Slot-7      :
Slot-8      :
Slot-3 Stack.2 #
```

Summit Family Switches Only

On Summit family switches, the output includes the current temperature and operating status of the switch.

The following shows a sample display from a Summit switch:

```
X150-24p.3 # show temperature
```

Field	Replaceable Units	Temp (C)	Status	Min	Normal	Max
Switch	: X150-24p	30.00	Normal	-10	0-52	57

The switch monitors its temperature and generates a warning if the temperature exceeds the normal operating range. If the temperature exceeds the maximum limit, the `show switch` output indicates the switch in an OPERATIONAL (Overheat) mode, and the `show temperature` output indicates an error state due to overheat.

Power Supply Temperature—Modular Switches Only

To view the current temperature of the power supplies installed in BlackDiamond X8 or 8800 series switches, use the following command:

```
show power {<ps_num>} {detail}
```

The following is sample output of temperature information:

```
PowerSupply 1 information:
...
Temperature:    30.1 deg C
...
```

Using the Event Management System/Logging

We use the general term, event, for any type of occurrence on a switch that could generate a log message or require an action. For example, a link going down, a user logging in, a command entered on the command line, or the software executing a debugging statement, are all events that might generate a log message. The system for saving, displaying, and filtering events is called the Event Management System (EMS). With EMS, you have many options about which events generate log messages, where the messages are sent, and how they are displayed.

Using EMS you can:

- Send event messages to a number of logging targets (for example, syslog host and NVRAM)
- Filter events per target, by:
 - Component, subcomponent, or specific condition (for example, BGP messages, *IGMP.Snooping* messages, or the *IP.Forwarding.SlowPathDrop* condition)
 - Match expression (for example, any messages containing the string “user5”)
 - Matching parameters (for example, only messages with source IP addresses in the 10.1.2.0/24 subnet)
 - Severity level (for example, only messages of severity critical, error, or warning)
- Change the format of event messages (for example, display the date as “12-May-2005” or “2005-05-12”)
- Display log messages in real time and filter the messages that are displayed, both on the console and from Telnet sessions
- Display stored log messages from the memory buffer or NVRAM
- Upload event logs stored in memory buffer or NVRAM to a TFTP server
- Display counts of event occurrences, even those not included in filter
- Display debug information using a consistent configuration method

EMS supports IPv6 as a parameter for filtering events.

Sending Event Messages to Log Targets

You can specify seven types of targets to receive log messages:

- Console display
- Current session (Telnet or console display)
- Memory buffer (can contain 200 to 20,000 messages)
- NVRAM (messages remain after reboot)
- Primary MSM/MM (for modular systems) or node (for SummitStack)
- Backup MSM/MM (for modular systems) or node (for SummitStack)
- Syslog host

The first six targets exist by default; but before enabling any syslog host, you must add the host's information to the switch using the `configure syslog` command. Extreme Networks Ridgeline can be a syslog target.

By default, the memory buffer and NVRAM targets are already enabled and receive messages. To start sending messages to the targets, use the following command:

```
enable log target [console | memory-buffer | nvram | primary-msm | primary-node |
backup-msm | backup-node | session | syslog [all | <ipaddress> | <ipPort>] {vr
<vr_name>} [local0 ... local7]]]
```

After you enable this feature, the target receives the messages for which it is configured. See “[Target Configuration](#)” later in this chapter for information on viewing the current configuration of a target. The memory buffer can contain only the configured number of messages, so the oldest message is lost when a new message arrives, when the buffer is full.

To stop sending messages to the target, use the following command:

```
disable log target [console | memory-buffer | nvram | primary-msm | primary-node |
backup-msm | backup-node | session | syslog [all | <ipaddress> | <ipPort>] {vr
<vr_name>} [local0 ... local7]]]
```



NOTE

Refer to your UNIX documentation for more information about the syslog host facility.

Primary and Backup Systems—Modular Switches and SummitStack Only

A system with dual MSMs/MMs (modular switches) or primary and backup nodes (SummitStack) keeps the two systems synchronized by executing the same commands on both. However, the full data between the EMS servers is not synchronized. The reason for this design decision is to make sure that the control channel is not overloaded when a high number of log messages are generated.

To capture events generated by the primary node onto the backup node, two additional targets are shown in the target commands—one called `primary-msm` (modular switches) or `primary-node` (SummitStack) and one called `backup-msm` (modular switches) or `backup-node` (SummitStack). The first target is active only on the non-primary (backup) EMS server and is used to send matching events to the primary EMS server. The other target is active only on the primary EMS server and is used to send matching events to all other EMS servers.

If the condition for the backup target is met by a message generated on the primary node, the event is sent to the backup node. When the backup node receives the event, it detects if any of the local targets (NVRAM, memory, or console) are matched. If so that event gets processed. The `session` and `syslog` targets are disabled on the backup node, as they are handled on the primary. If the condition for the primary target is met by a message generated on the backup, the event is sent to the primary node.

Note that the backup target is active only on the primary node, and the primary target is active only on the backup node.

Filtering Events Sent to Targets

Not all event messages are sent to every enabled target. Each target receives only the messages for which it is configured.

Target Configuration

To specify the messages to send to an enabled target, you set a message severity level, a filter name, and a match expression. These items determine which messages are sent to the target. You can also configure the format of the messages in the targets. For example, the console display target is configured to get messages of severity `info` and greater, the NVRAM target gets messages of severity `warning` and greater, and the memory buffer target gets messages of severity `debug-data` and greater. All the targets are associated by default with a filter named *DefaultFilter* that passes all events at or above the default severity threshold. All the targets are also associated with a default match expression that matches any messages (the expression that matches any message is displayed as `Match : (none)` from the command line). And finally, each target has a format associated with it.

To display the current log configuration of the targets, use the following command:

```
show log configuration target {console | memory-buffer | nvrाम | primary-msm |
primary-node | backup-msm | backup-node | session | syslog {<ipaddress> | <ipPort> |
vr <vr_name>} {[local0 ... local7]}}
```

To configure a target, you use specific commands for severity, filters, and formats. In addition, you can configure the source IP address for a syslog target. Configuring the source IP address allows the management station or syslog server to identify from which switch it received the log messages. To configure the source IP address for a syslog target, use the following command:

```
configure log target syslog [all | <ipaddress> | <ipPort>] {vr <vr_name>} {local0 ...
local7} from <source-ip-address>
```

The following sections describe the commands required for configuring filters, formats, and severity.

Severity

Messages are issued with one of the following severity levels: *Critical*, *Error*, *Warning*, *Notice*, *Info*, *Debug-Summary*, *Debug-Verbose*, or *Debug-Data*. When a message is sent to a syslog target, the severity is mapped to a corresponding syslog priority value (see RFC 3164).

The three severity levels for extended debugging—*Debug-Summary*, *Debug-Verbose*, and *Debug-Data*—require that log debug mode be enabled (which may cause a performance degradation). See [“Displaying Debug Information” on page 508](#) for more information about debugging.

Table 65: Severity Levels Assigned by the Switch

Level	Description
Critical	A serious problem has been detected that is compromising the operation of the system; the system cannot function as expected unless the situation is remedied. The switch may need to be reset.
Error	A problem has been detected that is interfering with the normal operation of the system; the system is not functioning as expected.
Warning	An abnormal condition, not interfering with the normal operation of the system, has been detected that indicate that the system or the network in general may not be functioning as expected.
Notice	A normal but significant condition has been detected, which signals that the system is functioning as expected.
Info (Informational)	A normal but potentially interesting condition has been detected, which signals that the system is functioning as expected; this level simply provides potentially detailed information or confirmation.
Debug-Summary	A condition has been detected that may interest a developer seeking the reason underlying some system behavior.
Debug-Verbose	A condition has been detected that may interest a developer analyzing some system behavior at a more verbose level than provided by the debug summary information.
Debug-Data	A condition has been detected that may interest a developer inspecting the data underlying some system behavior.

You can use more than one command to configure the severity level of the messages sent to a target. The most direct way to set the severity level of all the sent messages is to use the following command:

```
configure log target [console | memory-buffer | nvram | primary-msm | primayr-node |
backup-msm | backup-node | session | syslog [all | <ipaddress> | <ipPort> {vr
<vr_name>} [local0 ... local7]]] {severity <severity> {only}}
```

When you specify a severity level, messages of that severity level and greater are sent to the target. If you want only those messages of the specified severity to be sent to the target, use the keyword `only`. For example, specifying `severity warning` will send warning, error, and critical messages to the target, but specifying `severity warning only` sends only warning messages.

You can also use the following command to configure severity levels, which associate a filter with a target:

```
configure log target [console | memory-buffer | primary-msm | primary-node | backup-
msm | backup-node | nvram | session | syslog [all | <ipaddress> | <ipPort> {vr
<vr_name>} [local0 ... local7]]] filter <filter-name> {severity <severity> {only}}
```

When you specify a severity level as you associate a filter with a target, you further restrict the messages reaching that target. The filter may allow only certain categories of messages to pass. Only the messages that pass the filter and then pass the specified severity level reach the target.

Finally, you can specify the severity levels of messages that reach the target by associating a filter with a target. The filter can specify exactly which message it will pass. Constructing a filter is described in [“Filtering By Components and Conditions” on page 501](#).

Components and Conditions

The event conditions detected by ExtremeXOS are organized into components and subcomponents. To get a listing of the components and subcomponents in your release of ExtremeXOS, use the following command:

```
show log components {<event component>} {version}
```

For example, to get a list of the components and subcomponents in your system, use the following command:

```
show log components
```

The following is partial output from this command:

Component	Title	Severity Threshold
...		
...		
STP	Spanning-Tree Protocol (STP)	Error
InBPDU	STP In BPDU subcomponent	Warning
OutBPDU	STP Out BPDU subcomponent	Warning
System	STP System subcomponent	Error
...		
...		

The display above lists the components, subcomponents, and the severity threshold assigned to each. In EMS, you use a period (.) to separate component, subcomponent, and condition names. For example, you can refer to the *InBPDU* subcomponent of the STP component as *STP.InBPDU*. On the CLI, you can abbreviate or TAB complete any of these.

A component or subcomponent typically has several conditions associated with it. To see the conditions associated with a component, use the following command:

```
show log events [<event condition> | [all | <event component>] {severity <severity>
{only}}] {details}
```

For example, to see the conditions associated with the *STP.InBPDU* subcomponent, use the following command:

```
show log events stp.inbpdu
```

The following is sample output from this command:

Comp	SubComp	Condition	Severity	Parameters
STP	InBPDU	Drop	Error	2 total
STP	InBPDU	Dump	Debug-Data	3 total
STP	InBPDU	Trace	Debug-Verbose	2 total
STP	InBPDU	Ign	Debug-Summary	2 total
STP	InBPDU	Mismatch	Warning	2 total

The display above lists the five conditions contained in the *STP.InBPDU* component, the severity of the condition, and the number of parameters in the event message. In this example, the severities of the events in the *STP.InBPDU* subcomponent range from error to debug-summary.

When you use the `details` keyword, you see the message text associated with the conditions. For example, if you want to see the message text and the parameters for the event condition *STP.InBPDU.Trace*, use the following command:

```
show log events stp.inbpdu.trace details
```

The following is sample output from this command:

Comp	SubComp	Condition	Severity	Parameters
STP	InBPDU	Trace	Debug-Verbose	2 total 0 - string 1 - string (printf)
		Port=%0%: %1%		

The `Comp` heading shows the component name, the `SubComp` heading shows the subcomponent (if any), the `Condition` heading shows the event condition, the `Severity` heading shows the severity assigned to this condition, the `Parameters` heading shows the parameters for the condition, and the text string shows the message that the condition will generate. The parameters in the text string (for example, `%0%` and `%1%` above) will be replaced by the values of these parameters when the condition is encountered and displayed as the event message.

Filtering By Components and Conditions. You may want to send the messages that come from a specific component that makes up ExtremeXOS or to send the message generated by a specific condition. For example, you might want to send only those messages that come from the STP component, or send the message that occurs when the *IP.Forwarding.SlowPathDrop* condition occurs. Or you may want to exclude messages from a particular component or event. To do this, you construct a filter that passes only the items of interest, and you associate that filter with a target.

The first step is to create the filter using the `create log filter` command. You can create a filter from scratch, or copy another filter to use as a starting point. (It may be easiest to copy an existing filter and modify it.) To create a filter, use the following command:

```
create log filter <name> {copy <filter name>}
```

If you create a filter from scratch, that filter initially blocks all events until you add events (either the events from a component or a specific event condition) to pass. You might create a filter from scratch if you want to pass a small set of events and to block most events. If you want to exclude a small set of events, use the default filter that passes events at or above the default severity threshold (unless the filter has been modified), named *DefaultFilter*, that you can copy to use as a starting point for your filter.

After you create your filter, you configure filter items that include or exclude events from the filter. Included events are passed; excluded events are blocked. To configure your filter, use the following command:

```
configure log filter <name> [add | delete] {exclude} events [<event-condition> | [all  
| <event-component>] {severity <severity> {only}}]
```

For example, if you create the filter *myFilter* from scratch, use the following command to include events:

```
configure log filter myFilter add events stp
```

All STP component events of at least the default threshold severity passes *myFilter* (for the STP component, the default severity threshold is `error`). You can further modify this filter by specifying additional conditions.

For example, assume that *myFilter* is configured as before, and assume that you want to exclude the *STP.CreatPortMsgFail* event. To add that condition, use the following command:

```
configure log filter myFilter add exclude events stp.creatportmsgfail
```


Matching Expressions

You can configure the switch so messages reaching the target match a specified match expression. The message text is compared with the configured match expression to determine whether to pass the message on. To require that messages match a match expression, use the following command:

```
configure log target [console | memory-buffer | nvram | primary-msm | primary-node |
backup-msm | backp-node | session | syslog [all | <ipaddress> | <ipPort> {vr
<vr_name>} [local0 ... local7]]] match [any |<match-expression>]
```

The messages reaching the target will match the `match-expression`, a simple regular expression. The formatted text string that makes up the message is compared with the match expression and is passed to the target if it matches. This command does not affect the filter in place for the target, so the match expression is compared only with the messages that have already passed the target's filter. For more information on controlling the format of the messages, see [“Formatting Event Messages” on page 505](#).

Simple Regular Expressions. A simple regular expression is a string of single characters including the dot character (`.`), which are optionally combined with quantifiers and constraints. A dot matches any single character, while other characters match only themselves (case is significant). Quantifiers include the star character (`*`) that matches zero or more occurrences of the immediately preceding token. Constraints include the caret character (`^`) that matches at the beginning of a message and the currency character (`$`) that matches at the end of a message. Bracket expressions are not supported. There are a number of sources available on the Internet and in various language references describing the operation of regular expressions. [Table 66](#) shows some examples of regular expressions.

Table 66: Simple Regular Expressions

Regular Expression	Matches	Does Not Match
port	port 2:3 import cars portable structure	poor por pot
..ar	baar bazaar rebar	bar
port.*vlan	port 2:3 in vlan test add ports to vlan port/vlan	
myvlan\$	delete myvlan error in myvlan	myvlan port 2:3 ports 2:4,3:4 myvlan link down

Matching Parameters

Rather than using a text match, EMS allows you to filter more efficiently based on the parameter values of the message. In addition to event components and conditions and severity levels, each filter item can also use parameter values to further limit which messages are passed or blocked. The process of creating, configuring, and using filters has already been described in [“Filtering By Components and Conditions” on page 501](#), so this section describes matching parameters with a filter item.

To configure a parameter match filter item, use the following command:

```
configure log filter <name> [add | delete] {exclude} events [<event-condition> | [all
| <event-component>] {severity <severity> {only}}] [match | strict-match] <type>
<value>
```

Each event in ExtremeXOS is defined with a message format and zero or more parameter types. The `show log events all` command can be used to display event definitions (the event text and

parameter types). Only those parameter types that are applicable given the events and severity specified are exposed on the CLI. The syntax for the parameter types (represented by <type> in the command syntax above) is:

```
[address-family [ipv4-multicast | ipv4-unicast | ipv6-multicast | ipv6-unicast]
| bgp-neighbor <ip address>
| bgp-routerid <ip address>
| eaps <eaps domain name>
| {destination | source} [ipaddress <ip address> | L4-port <L4-port>| mac-address
<mac-address>]
| esrp <esrp domain name>
| {egress | ingress} [slot <slot number> | ports <portlist>]
| ipaddress <ip address>
| L4-port <L4-port>
| mac-address <mac_address>
| netmask <netmask>
| number <number>
| port <portlist>
| process <process name>
| slot <slotid>
| string <exact string to be matched>
| vlan <vlan name>
| vlan tag <vlan tag>]
```

You can specify the `ipaddress` type as IPv4 or IPv6, depending on the IP version. The following examples show how to configure IPv4 addresses and IPv6 addresses:

- IPv4 address

To configure an IP address, with a mask of 32 assumed, use the following command:

```
configure log filter myFilter add events all match ipaddress 12.0.0.1
```

To configure a range of IP addresses with a mask of 8, use the following command:

```
configure log filter myFilter add events all match ipaddress 12.0.0.0/8
```

- IPv6 address

To configure an IPv6 address, with a mask of 128 assumed, use the following command:

```
configure log filter myFilter add events all match ipaddress 3ffe::1
```

To configure a range of IPv6 addresses with a mask of 16, use the following command:

```
configure log filter myFilter add events all match ipaddress 3ffe::/16
```

- IPv6 scoped address

IPv6 scoped addresses consist of an IPv6 address and a VLAN. The following examples identify a link local IPv6 address.

To configure a scoped IPv6 address, with a mask of 128 assumed, use the following command:

```
configure log filter myFilter add events all match ipaddress fe80::1%Default
```

To configure a range of scoped IPv6 addresses with a mask of 16, use the following command:

```
configure log filter myFilter add events all match ipaddress fe80::/16%Default
```

To configure a scoped IPv6 address with any VLAN, use the following command:

```
configure log filter myFilter add events all match ipaddress fe80::/16*
```

To configure any scoped IPv6 address with a specific VLAN, use the following command:

```
configure log filter myFilter add events all match ipaddress fe80::/0%Default
```

**NOTE**

In the previous example, if you specify the VLAN name, it must be a full match; wild cards are not allowed.

The `<value>` depends on the parameter type specified. As an example, an event may contain a physical port number, a source MAC address, and a destination MAC address. To allow only those RADIUS incidents, of severity `notice` and above, with a specific source MAC address, use the following command:

```
configure log filter myFilter add events aaa.radius.requestInit severity notice match
source mac-address 00:01:30:23:C1:00
```

The string type is used to match a specific string value of an event parameter, such as a user name. The exact string is matched with the given parameter and no regular expression is supported.

Match Versus Strict-Match. The `match` and `strict-match` keywords control the filter behavior for those incidents with event definition that does not contain all the parameters specified in a `configure log filter events match` command.

This is best explained with an example. Suppose an event in the XYZ component, named `XYZ.event5`, contains a physical port number, a source MAC address, but no destination MAC address. If you configure a filter to match a source MAC address and a destination MAC address, `XYZ.event5` will match the filter when the source MAC address matches regardless of the destination MAC address because the event contains no destination MAC address. If you specify the `strict-match` keyword, then the filter will never match event `XYZ.event5` because this event does not contain the destination MAC address.

In other words, if the `match` keyword is specified, an incident will pass a filter so long as all parameter values in the incident match those in the match criteria, but all parameter types in the match criteria need not be present in the event definition.

Formatting Event Messages

Event messages are made up of a number of items. The individual items can be formatted; however, EMS does not allow you to vary the *order* of the items. To format the messages for a particular target, use the following command:

```
configure log target format
```

Using the default format for the session target, an example log message might appear as:

```
06/25/2004 22:49:10.63 <Info:dm.Info> MSM-A: PowerSupply:4 Powered On
```

If you set the current session format using the following command:

```
configure log target session format timestamp seconds date mm-dd-yyyy event-name
component
```

The same example would appear as:

```
06/25/2004 22:49:10 <dm> PowerSupply:4 Powered On
```

To provide some detailed information to technical support, set the current session format using the following command:

```
configure log target session format timestamp hundredths date mmm-dd event-name
condition process-name source-line
```

The same example then appears as:

```
Jun 25 22:49:10.63 <dm.info> devmgr: (dm.c:134) PowerSupply:4 Powered On
```

Displaying Real-Time Log Messages

You can configure the system to maintain a running real-time display of log messages on the console display or on a (Telnet) session. To turn on the log display on the console, use the following command:

```
enable log target console
```

This setting may be saved to the FLASH configuration and is restored on boot-up (to the console display session).

To turn on log display for the current session, use the following command:

```
enable log target session
```

This setting only affects the current session and is lost when you log off the session.

The messages that are displayed depend on the configuration and format of the target. For information on message filtering, see [“Filtering Events Sent to Targets” on page 498](#). for information on message formatting, see [“Formatting Event Messages” on page 505](#).

Displaying Event Logs

The log stored in the memory buffer and the NVRAM can be displayed on the current session (either the console display or Telnet). To display the log, use the following command:

```
show log {messages [memory-buffer | nvramp]} {events {<event-condition> | <event-
component>}} {severity <severity> {only}} {starting [date <date> time <time> | date
<date> | time <time>]} {ending [date <date> time <time> | date <date> | time <time>]}
{match <regex>} {chronological}
```

You can use many options to select those log entries of interest. You can select to display only those messages that conform to the specified:

- Severity
- Starting and ending date and time
- Match expression

The displayed messages can be formatted differently from the format configured for the targets, and you can choose to display the messages in order of newest to oldest or in chronological order (oldest to newest).

Uploading Event Logs

The log stored in the memory buffer and the NVRAM can be uploaded to a TFTP server. Use the following command to upload the log:

```
upload log <ipaddress> {vr <vr_name>} <filename> {messages [memory-buffer | nvrn]
{events {<event-condition> | <event_component>}} {severity <severity> {only}} {match
<regex>} {chronological}}
```

You must specify the TFTP host and the filename to use in uploading the log. There are many options you can use to select the log entries of interest. You can select to upload only those messages that conform to the specified:

- Severity
- Match expression

The uploaded messages can be formatted differently from the format configured for the targets, and you can choose to upload the messages in order of newest to oldest or in chronological order (oldest to newest).

Displaying Counts of Event Occurrences

EMS adds the ability to count the number of occurrences of events. Even when an event is filtered from all log targets, the event is counted. To display the event counters, use the following command:

```
show log counters {<event condition> | [all | <event component>]} {include | notified
| occurred} {severity <severity> {only}}
```

The system displays two counters. One counter displays the number of times an event has occurred, and the other displays the number of times that notification for the event was made to the system for further processing. Both counters reflect totals accumulated since reboot or since the counters were cleared using the `clear log counters` or `clear counters` command.

The `show log counters` command also displays an included flag (the column titled `In` in the output). The included flag is set to `Y(es)` if one or more targets are receiving notifications of this event without regard to matching parameters.

The keywords `include`, `notified`, and `occurred` display events only with non-zero counter values for the corresponding counter.

The output of the command:

```
show log counters stp.inbpdud severity debug-summary
```

is similar to the following:

Comp	SubComp	Condition	Severity	Occurred	In	Notified
STP	InBPDU	Drop	Error	0	Y	0
STP	InBPDU	Ign	Debug-Summary	0	N	0
STP	InBPDU	Mismatch	Warning	0	Y	0

```
Occurred : # of times this event has occurred since last clear or reboot
Flags : (*) Not all applications responded in time with there count values
In(cluded): Set to Y(es) if one or more targets filter includes this event
Notified : # of times this event has occurred when 'Included' was Y(es)
```

The output of the command:

```
show log counters stp.inbpdud.drop
```

is similar to the following:

Comp	SubComp	Condition	Severity	Occurred	In	Notified
STP	InBPDU	Drop	Error	0	Y	0

STP	InBPDU	Drop	Error	0	Y	0
-----	--------	------	-------	---	---	---

Occurred : # of times this event has occurred since last clear or reboot
Flags : (*) Not all applications responded in time with there count values
In(cluded): Set to Y(es) if one or more targets filter includes this event
Notified : # of times this event has occurred when 'Included' was Y(es)

Displaying Debug Information

By default, a switch does not generate events of severity `Debug-Summary`, `Debug-Verbose`, and `Debug-Data` unless the switch is in debug mode. Debug mode causes a performance penalty, so it should only be enabled for specific cases where it is needed. To place the switch in debug mode, use the following command:

```
enable log debug-mode
```

When the switch is in debug-mode, any filters configured for your targets still affect which messages are passed on or blocked.

Logging Configuration Changes

ExtremeXOS allows you to record all configuration changes and their sources that are made using the CLI by way of telnet or the local console. The changes cause events that are logged to the target logs. Each log entry includes the user account name that performed the change and the source IP address of the client (if telnet was used). Configuration logging applies only to commands that result in a configuration change.

To enable configuration logging, use the following command:

```
enable cli-config-logging
```

To disable configuration logging, use the following command:

```
disable cli-config-logging
```

CLI configuration logging is disabled by default.

Using the XML Notification Client

Introduction

This feature allows an event such as a configuration change, a fault, a change in status, the crossing of a threshold, or an external input to the system, to be sent as an asynchronous message or event notification to external Web servers. The only ExtremeXOS modules that support XML notification as targets are Identity Management and EMS.

XML notification does not provide any event filtering capability. However, in the case of EMS, the target Web server can be configured with log filters and conditions. The XML notification feature establishes and checks the connectivity with the Web server only when an event is ready to be pushed. State transitions take place if required. Statistics are updated accordingly and can be monitored.

The Web servers must be configured and enabled using ExtremeXOS CLI with an IP address, port, protocol type, user authentication, session information, if any, and other Web server configuration. A maximum of four Web servers can be configured at a time.

The XML schemas are defined using Web Services Description Language (WSDL) in the XML SDK.

XML Notification is supported on BlackDiamond 8000 series modules and Summit family switches.

HTTP Client Interface

The event notifications are sent in XML format, using SOAP transport protocol and HTTP/HTTPS.

The XML notification client can communicate with the external HTTP/HTTPS server. HTTP/HTTPS client interfaces maintain persistent connections with external Web servers as long as the target is activated on the switch.

The HTTP URL format for the server is "http://<ip-address>:<port>/<service>". The default HTTP port number 80 is used if a port number is not configured.

HTTP basic access authentication method (Base64 algorithm) is used to encrypt the user name and password when making a request. HTTP cookies are not supported in this release.

The SSH module must be installed on the ExtremeXOS switch to use the XML notification feature on HTTPS. Once the SSH module is installed, a server certificate should be created that can be used by the HTTPS server. Refer to the configuration guidelines of the HTTP server, to generate the secure certificate on the ExtremeXOS switch. (See “[Secure Socket Layer](#)” on page 908)

Configuring XML Notification

To create a Web server target on an XML client, use the following command:

```
create xml-notification target <new-target> url <url> {vr <vr_name>} {user [none | <user>]} {encrypted-auth <encrypted-auth>} {queue-size <queue-size>}
```

To configure a Web server target on an XML client, use the following command:

```
configure xml-notification target <target> [url <url> {vr <vr_name>} | user [none | <user>] | [encrypted-auth <encrypted-auth>] | [queue-size <queue-size>]]
```

To add or delete an ExtremeXOS application to a Web server target (EMS or Identity Management), use the following command:

```
configure xml-notification target <target> [add | delete] <module>
```

To enable or disable Web server target(s), use the following command:

```
[enable|disable] xml-notification [all | <target>]
```

To delete a Web server target on an XML client process, use the following command:

```
delete xml-notification target <target>
```

To unconfigure an XML client process, use the following command:

```
unconfigure xml-notification
```

To unconfigure and reset all statistics counters, use the following command:

```
clear counters xml-notification {all | <target>}
```

Displaying XML Notification

To display the configuration of a Web server target, use the following command:

```
show xml-notification configuration {<target>}
```

To display the connection status, enable status, and event statistics of the target Web server, use the following command:

```
show xml-notification statistics {<target>}
```

To display information on the stored certificate, use the following command:

```
show ssl {detail}
```

Configuring Log Target in EMS

The following commands support the EMS XML target.

To create a Web server XML target, use the following command:

```
create log target xml-notification [ <target_name> | <xml_target_name> ]
```

To configure the Web server target with an EMS filter, use the following command:

```
configure log target xml-notification <xml_target_name> filter <filter-name> {severity
[ [<severity> ] {only}}}
```

To enable the Web server target, use the following command:

```
enable log target xml-notification <xml_target_name>
```

To disable the Web server target, use the following command:

```
disable log target xml-notification <xml_target_name>
```

To delete the Web server target XML target, use the following command:

```
delete log target xml-notification <xml_target_name>
```

To display XML target information, use the following command:

```
show log configuration target xml-notification {<xml_target_name>}
```

Examples

Following are examples of configuring Web server targets in a XML Notification module.

Scenario - 1: Push filtered EMS events to external Web server in a well defined XML format.

Create a Web Server Target `test1`, create a log target and a filter in EMS, and attach the filter to the Web target. Enable the target in both EMS and XML-Notification module.

```
create XML-notification target test1 url http://10.255.129.22:8080/xos/webservice user
admin
create log target xml-notification "test1"
create log filter xmlc_filter_1
configure log filter "xmlc_filter_1" add events idmgr
configure log target xml-notification "test1" filter "xmlc_filter-1"
enable log target xml-notification "test1"
```

```
enable XML-notification test1
```

Scenario - 2: Push user identity events to the external Web server without EMS module in a well defined (XML Schema) XML format.

Create a Web server target and attach an `idmgr` module. `Idmgr` modules use an XML-notification backend library to trigger events. In this case no special filters are supported.

```
create xml-notification target test2 url http://10.255.129.22:8080/xos/webservice user
admin
configure xml-notification target test2 add module idmgr
enable xml-notification test2
```

Scenario - 3: XMLC notifications using HTTPS

Install the SSH module (If not installed, refer to “Secure Shell 2” on page 900 for details on SSH and “Secure Socket Layer” on page 908 for details on SSL)

```
configure ssl certificate privkeylen 1024 country us organization extreme common-name
name1
create xml-notification target test3 url https://10.120.91.64:8443/xos/webservice
configure xml-notification target "test3" user admin
configure xml-notification target "test3" add "ems"
enable xml-notification "test3"
```

Using sFlow

sFlow is a technology for monitoring traffic in data networks containing switches and routers. It relies on statistical sampling of packets from high-speed networks, plus periodic gathering of the statistics. A User Datagram Protocol (UDP) datagram format is defined to send the information to an external entity for analysis. sFlow consists of a Management Information Base (MIB) and a specification of the packet format for forwarding information to a remote agent. Details of sFlow specifications can be found in RFC 3176, and specifications and more information can be found at the following website:

<http://www.sflow.org>

The ExtremeXOS implementation is based on sFlow version 5, which is an improvement from the revision specified in RFC 3176. Additionally, the switch hardware allows you to set the hardware sampling rate independently for each module on the switch, instead of requiring one global value for the entire switch. The switch software also allows you to set the individual port sampling rates, so you can fine-tune the sFlow statistics gathering. Per the RFC, sFlow sampling is done on ingress only.

sFlow and mirroring are not mutually exclusive on BlackDiamond 8000 a-, c-, e-, xl-, xm-series modules, and Summit family switches, whether or not they are included in a SummitStack. You can enable sFlow and mirroring at the same time.

You can enable sFlow and mirroring at the same time on the following platforms:

- BlackDiamond 8000 series modules
- Summit family switches

However, you should be aware of a few limitations. The following are supported in ExtremeXOS implementation:

- Generic port statistics reported to the sFlow collector
- Non-extended data
- Only port-based sampling

**NOTE**

On the BlackDiamond 10808, 12800 series, and 20800 series switches, sFlow does not work with LAG. You should apply sFlow on each port.

There is no MIB support.

This section describes the following topics:

- [Sampling Mechanisms on page 513](#)
- [Configuring sFlow on page 513](#)
- [Additional sFlow Configuration Options on page 515](#)
- [sFlow Configuration Example on page 516](#)
- [Displaying sFlow Information on page 517](#)

**NOTE**

For information on licensing, see [Appendix A, "Feature License Requirements."](#)

Sampling Mechanisms

The following platforms support hardware-based sampling at a programmed interval:

- BlackDiamond 8000 series modules
- Summit family switches

With hardware-based sampling, the data path for a packet that traverses the switch does not require processing by the CPU. Fast path packets are handled entirely by ASICs and are forwarded at wire speed rate.

With software-based sampling, the data path for the packets is still fast path; however, the switch copies all packets to the CPU for sampling (instead of only those that have been marked for sampling). Software sampling requires intensive CPU processing.

Configuring sFlow

ExtremeXOS allows you to collect sFlow statistics on a per port basis. An agent, residing locally on the switch, sends data to a collector that resides on another machine. You configure the local agent, the address of the remote collector, and the ports of interest for sFlow statistics gathering. You can also modify default values for how frequently on average a sample is taken and the maximum number of samples allowed before throttling the sample gathering.

To configure sFlow on a switch, you must do the following tasks:

- Configure the local agent
- Configure the addresses of the remote collectors
- Enable sFlow globally on the switch
- Enable sFlow on the desired ports

Optionally, you may also change the default values of the following items:

- How often the statistics are collected
- How frequently a sample is taken, globally or per port
- How many samples per second can be sent to the CPU

Configuring the Local Agent

The local agent is responsible for collecting the data from the samplers and sending that data to the remote collector as a series of UDP datagrams. The agent address is stored in the payload of the sFlow data, and is used by the sFlow collector to identify each agent uniquely. By default, the agent uses the management port IP address as its IP address. To change the agent IP address, use the following command:

```
configure sflow agent {ipaddress} <ip-address>
```

To unconfigure the agent, use the following command:

```
unconfigure sflow agent
```

Configuring the Remote Collector Address

You can specify up to four remote collectors to send the sFlow data to. Typically, you would configure the IP address of each collector. You may also specify a UDP port number different from the default value of 6343, and/or a virtual router different from the default of *VR-Mgmt*. When you configure a collector, the system creates a database entry for that collector that remains until the collector is unconfigured. All the configured collectors are displayed in the `show sflow {configuration}` command. To configure the remote collector, use the following command:

```
configure sflow collector {ipaddress} <ip-address> {port <udp-port-number>} {vr <vrname>}
```

To unconfigure the remote collector and remove it from the database, use the following command:

```
unconfigure sflow collector {ipaddress} <ip-address> {port <udp-port-number>} {vr <vrname>}
```

Enabling sFlow Globally on the Switch

Before the switch starts sampling packets for sFlow, you must enable sFlow globally on the switch. To enable sFlow globally, use the following command:

```
enable sflow
```

To disable sFlow globally, use the following command:

```
disable sflow
```

When you disable sFlow globally, the individual ports are also put into the disabled state. If you later enable the global sFlow state, individual ports return to their previous state.

Enabling sFlow on the Desired Ports

To enable sFlow on specific ports, use the following command:

```
enable sflow ports <port_list>
```

You may enable and disable sFlow on ports irrespective of the global state of sFlow, but samples are not taken until *both* the port state and the global state are enabled.

To disable sFlow on ports, use the following command:

```
disable sflow ports <portlist>
```

Additional sFlow Configuration Options

You can configure three global options to different values from the defaults. These options affect how frequently the sFlow data is sent to the remote collector, how frequently packets are sampled, and the maximum number of sFlow samples that could be processed in the CPU per second.

You can also configure how frequently packets are sampled per port.

Polling Interval

Each port counter is periodically polled to gather the statistics to send to the collector. If there is more than one counter to be polled, the polling is distributed in such a way that each counter is visited once during each polling interval, and the data flows are spaced in time. For example, assume that the polling interval is 20 seconds and there are 40 counters to poll. Two ports will be polled each second, until all 40 are polled. To configure the polling interval, use the following command:

```
configure sflow poll-interval <seconds>
```

Global Sampling Rate

The global sampling rate is the rate that newly enabled sFlow ports will have their sample rate set to. Changing this rate does not affect currently enabled sFlow ports. The default sample rate is 8192, so by default sFlow samples one packet out of every 8192 received. To configure the switch to use a different sampling rate, use the following command:

```
configure sflow sample-rate <number>
```

For example, if you set the sample rate number to 16384, the switch samples one out of every 16384 packets received. Higher numbers mean fewer samples and longer times between samples. If you set the number too low, the number of samples can be very large, which increases the load on the switch. Do not configure the sample rate to a number lower than the default unless you are sure that the traffic rate on the source is low.

Summit X450a, X440, X450e, X460, X480, X650, and X670 Series Switches and BlackDiamond 8000 a-, c-, e-, xl-, and xm-Series Modules Only. The minimum rate that these platforms sample is 1 out of every 256 packets. If you configure a rate to be less than 256, the switch automatically rounds up the sample rate to 256.

Per Port Sampling Rate

The per port sampling rate overrides the system-wide value set in the `configure sflow sample-rate` command. The rate is rounded off to the next power of two, so if 400 is specified, the sample rate is configured as 512. The valid range is 1 to 536870912. To set the sampling rate on individual ports, use the following command:

```
configure sflow ports <portlist> sample-rate <number>
```

Summit Family Switches, BlackDiamond 8000 a-, c-, e-, xl-, and xm-Series Modules, BlackDiamond 10808, 12800 and 20800 Series Switches Only. All ports on the switch or the same I/O module are sampled individually.

Maximum CPU Sample Limit

A high number of samples can cause a heavy load on the switch CPU. To limit the load, there is a CPU throttling mechanism to protect the switch.

On a modular switch, whenever the limit is reached, the sample rate value is doubled on the slot from which the maximum number of samples are received. For ports on that slot that are sampled less frequently, the sampling rate is not changed; the sub-sampling factor is adjusted downward.

On a stand-alone switch, whenever the limit is reached, the sample rate value is doubled on the ports from which the maximum number of samples are received. For ports that are sampled less frequently, the sampling rate is not changed; the sub-sampling factor is adjusted downward.

To configure the maximum CPU sample limit, use the following command:

```
configure sflow max-cpu-sample-limit <rate>
```

Unconfiguring sFlow

To reset the configured values for sFlow to their default values and remove from sFlow any configured collectors and ports, use the following command:

```
unconfigure sflow
```

sFlow Configuration Example

In a service provider environment, you can configure sFlow to sample packets at the edge of the network to determine the hourly usage for each IP address in the data center. You can capture Web traffic, FTP traffic, mail traffic, and all bits of data that travel across service providers' edge routers to their customers' (end users') servers.

The example in this section assumes that you already have an sFlow data collector installed somewhere in your network. In many environments, the sFlow data collector is on a network PC.

The following sFlow configuration example for a service provider environment:

- Configures the IP address of the sFlow data collector.



NOTE

In many environments, the sFlow data collector is not directly connected to the switch. Make sure to specify the VR used to forward traffic between the sFlow collector and the switch. In most cases the VR is VR-Mgmt.

- Configures the sampling rate on an edge port.
- Enables sFlow on the edge port.
- Enables sFlow globally on the switch.

```
configure sflow collector 55.55.55.69 vr vr-mgmt
configure sflow ports 4:12 sample-rate 1024
enable sflow ports 4:12
enable sflow
```

Displaying sFlow Information

To display the current configuration of sFlow, use the following command:

```
show sflow {configuration}
```

To display the sFlow statistics, use the following command:

```
show sflow statistics
```

Using RMON

Using the Remote Monitoring (RMON) capabilities of the switch allows network administrators to improve system efficiency and reduce the load on the network.

This section describes the following topics:

- [About RMON on page 517](#)
- [Supported RMON Groups of the Switch on page 518](#)
- [Configuring RMON on page 520](#)
- [Event Actions on page 521](#)
- [Displaying RMON Information on page 521](#)



NOTE

You can use the RMON features of the system only if you have an RMON management application and have enabled RMON on the switch.

About RMON

RMON is the common abbreviation for the Remote Monitoring Management Information Base (MIB) system defined by the Internet Engineering Task Force (IETF) documents RFC 1757 and RFC 2021, which allows you to monitor LANs remotely.

A typical RMON setup consists of the following two components:

- RMON agent
- Management workstation

RMON Agent

An RMON agent is an intelligent software agent that continually monitors port statistics and system variables. The agent transfers the information to a management workstation on request, or when a predefined threshold is crossed.

Information collected by RMON includes Ethernet port statistics and history and the software version and hardware revision of the device. RMON generates alarms when threshold levels are met and then logs those events to the log. RMON can also send traps to the destination address configured by the management workstation. You can also use RMON to trigger a system reboot.

Management Workstation

A management workstation communicates with the RMON agent and collects the statistics from it. The workstation does not have to be on the same network as the RMON agent and can manage the agent by in-band or out-of-band connections.

If you enable RMON on the switch, you can use a management workstation to review port statistics and port history, no configuration of the management workstation is necessary. However, you must use a management workstation to configure the alarm and event entries.

Supported RMON Groups of the Switch

The IETF defines nine groups of Ethernet RMON statistics. The switch supports the following four of these groups, as defined in RFC 1757:

- Statistics
- History
- Alarms
- Events

The switch also supports the following parameters for configuring the RMON agent and the trap destination table, as defined in RFC 2021:

- probeCapabilities
- probeSoftwareRev
- probeHardwareRev
- probeDateTime
- probeResetControl
- trapDestTable

The following sections describe the supported groups, the RMON probe configuration parameters, and the trap destination parameter in greater detail.

Statistics

The RMON Ethernet Statistics group provides traffic and error statistics showing packets, bytes, broadcasts, multicasts, and errors on an Ethernet port.

Information from the Statistics group is used to detect changes in traffic and error patterns in critical areas of the network.

History

The History group provides historical views of network performance by taking periodic samples of the counters supplied by the Statistics group. The group features user-defined sample intervals and bucket counters for complete customization of trend analysis.

The group is useful for analysis of traffic patterns and trends on an Ethernet port, and to establish baseline information indicating normal operating parameters.

Alarms

The Alarms group provides a versatile, general mechanism for setting threshold and sampling intervals to generate events on any RMON variable. Both rising and falling thresholds are supported, and thresholds can be on the absolute value of a variable or its delta value.

Note, creating an entry in the alarmTable does not validate the alarmVariable and does not generate a badValue error message.

Alarms inform you of a network performance problem and can trigger automated action responses through the Events group.

Events

The Events group creates entries in an event log and/or sends SNMP traps to the management workstation. An event is triggered by an RMON alarm. The action taken can be configured to ignore it, to log the event, to send an SNMP trap to the receivers listed in the trap receiver table, or to both log and send a trap. The RMON traps are defined in RFC 1757 for rising and falling thresholds.

Effective use of the Events group saves you time. Rather than having to watch real-time graphs for important occurrences, you can depend on the Events group for notification. Through the SNMP traps, events can trigger other actions, which provides a mechanism for an automated response to certain occurrences.

RMON Probe Configuration Parameters

The RMON probe configuration parameters supported in ExtremeXOS are a subset of the probe configuration group as defined in RFC 2021. The probe configuration group controls and defines the operation of the RMON agent.

You can configure the following objects:

- probeCapabilities—If you configure the probeCapabilities object, you can view the RMON MIB groups supported on at least one interface by the probe.
- probeSoftwareRev—If you configure the probeSoftwareRev object, you can view the current software version of the monitored device.
- probeHardwareRev—If you configure the probeHardwareRev object, you can view the current hardware version of the monitored device.
- probeDateTime—If you configure the probeDateTime object, you can view the current date and time of the probe. For example, Friday December 31, 2004 at 1:30:15 PM EST is displayed as: 2004-12-31,13:30:15.0

If the probe is aware of time zones, the display also includes the Greenwich Mean Time (GMT) offset. For example, Friday, December 31, 2004, 1:30:15 PM EST with the offset known is displayed as: 2004-12-31,13:30:15.0, -4.0

If time information is unavailable or unknown, the time is not displayed.

- probeResetControl—If you configure the probeResetControl object, you can restart a managed device that is not running normally. Depending on your configuration, you can do one of the following:
 - Warm boot—A warm boot restarts the device using the current configuration saved in non-volatile memory.
 - Cold boot—A cold boot causes the device to reset the configuration parameters stored in non-volatile memory to the factory defaults and then restarts the device using the restored factory default configuration.

trapDestTable

The trapDestTable contains information about the configured trap receivers on the switch and stores this information in non-volatile memory. To configure one or more trap receivers, see “Using the Simple Network Management Protocol,” in Chapter 2, “Managing the Switch.”

Extreme-RtStats-MIB

The extremeRtStatsTable provides the user with all the common measurement/monitoring attributes in a single table. It includes measurements like utilization, error, and collision levels.

The extreme RtStatsUtilization variable gives an accurate measurement of segment utilization. ExtremeRtStatsCollisions is included in the segment utilization calculation for more accuracy. Collision statistics are collected periodically, and the segment utilization is calculated with a sampling interval of 5 minutes (300 seconds).

The extremeRtStatsTotalErrors variable is calculated by adding the following counters:

- extremeRtStatsCRCAlignErrors (receive errors)
- extremeRtStatsFragments (receive errors)
- extremeRtStatsJabbers (receive errors)
- extremeRtStatsCollisions (transmit errors)

Configuring RMON

RMON requires one probe per LAN segment, and stand-alone RMON probes traditionally have been expensive. Therefore, the approach taken by Extreme Networks has been to build an inexpensive RMON probe into the agent of each system. This allows RMON to be widely deployed around the network without costing more than traditional network management. The switch accurately maintains RMON statistics at the maximum line rate of all of its ports.

To enable or disable the collection of RMON statistics on the switch, use one of the following commands:

```
enable rmon  
disable rmon
```

By enabling RMON, the switch begins the processes necessary for collecting switch statistics. By default, RMON is disabled. However, even in the disabled state, the switch collects etherStats and you can configure alarms and events.

RMON saves the history, alarm, and event configurations to the configuration file. Runtime data is not stored in the configuration file and is subsequently lost after a system restart.

Event Actions

The actions that you can define for each alarm are shown in [Table 67](#).

Table 67: Event Actions

Action	High Threshold
no action	
log	Sends a log message.
log-and-trap	Sends both a log message and a trap to all trap receivers.
snmp-trap	Sends a trap to all trap receivers.

To be notified of events using SNMP traps, you must configure one or more trap receivers, as described in the section, “[Using the Simple Network Management Protocol](#),” in [Chapter 2, “Managing the Switch](#).”

Displaying RMON Information

To view the status of RMON polling on the switch (the enable/disable state for RMON polling), use the following command:

```
show management
```

To view the RMON memory usage statistics for a specific RMON feature (for example, statistics, events, logs, history, or alarms) or for all features, use the following command:

```
show rmon memory {detail | <memoryType>}
```

SMON

SMON is the common abbreviation for the Switch Network Monitoring Management Information Base (MIB) system defined by the Internet Engineering Task Force (IETF) document RFC 2613. SMON is a set of MIB extensions for RMON that allows monitoring of switching equipment from a SNMP Manager in greater detail. The supported MIB tables are described in [Appendix E, “Supported Standards, Protocols, and MIBs”](#); `smonPrioStatsControlTable` and `smonPrioStatsTable` cannot be supported due to hardware limitations.



NOTE

When you delete all the mirroring filters through the `portCopyConfigTable`, the mirroring is disabled automatically.

Monitoring CPU Utilization

You can monitor the CPU utilization and history for all of the processes running on the switch. By viewing this history on a regular basis, you can see trends emerging and identify processes with peak utilization. Monitoring the workload of the CPU allows you to troubleshoot and identify suspect processes before they become a problem. By default, the switch monitors CPU utilization every 5 seconds. In addition, when CPU utilization of a process exceeds 90% of the regular operating basis, the

switch logs an error message specifying the process name and the current CPU utilization for the process.

Disabling CPU Monitoring

To disable CPU monitoring, use the following command:

```
disable cpu-monitoring
```

This command disables CPU monitoring on the switch; however, it does not clear the monitoring interval. Therefore, if you altered the monitoring interval, this command does not return the monitoring interval to 5 seconds. The next time you enable CPU monitoring, the switch uses the existing configured interval.

Enabling CPU Monitoring

To enable CPU monitoring, use the following command:

```
enable cpu-monitoring {interval <seconds>} {threshold <percent>}
```

Where the following is true:

- `seconds`—Specifies the monitoring interval. The default interval is 5 seconds, and the range is 5 to 60 seconds. Extreme Networks recommends the default setting for most network environments.
- `threshold`—Specifies the CPU threshold value. CPU usage is measured in percentages. The default is 90%, and the range is 0% to 100%.

By default, CPU monitoring is enabled and occurs every 5 seconds. The default CPU threshold value is 90%.

Displaying CPU Utilization History

To display the CPU utilization history of one or more processes, use the following command:

```
show cpu-monitoring {process <name>} {slot <slotid>}
```

Where the following is true:

- `name`—Specifies the name of the process.
- `slot`—For a modular chassis, specifies the slot number of the MSM/MM. A specifies the MSM installed in slot A. B specifies the MSM installed in slot B. On a SummitStack, specifies the slot number of the target node. The number is a value from 1 to 8. (This parameter is available only on modular switches and SummitStack.)

Output from this command includes the following information:

- `Card`—The location (MSM A or MSM B) where the process is running on a modular switch.
- `Process`—The name of the process.
- `Range of time (5 seconds, 10 seconds, and so forth)`—The CPU utilization history of the process or the system. The CPU utilization history goes back only 1 hour.
- `Total User/System CPU Usage`—The amount of time recorded in seconds that the process spends occupying CPU resources. The values are cumulative meaning that the values are displayed as long as the system is running. You can use this information for debugging purposes to see where the process spends the most amount of time: user context or system context.

The following is sample truncated output from a modular switch:

```
show cpu-monitoring
```

```

CPU Utilization Statistics - Monitored every 5 seconds
-----

```

Card	Process	5 secs util (%)	10 secs util (%)	30 secs util (%)	1 min util (%)	5 mins util (%)	30 mins util (%)	1 hour util (%)	Max util (%)	Total User/System CPU Usage (secs)
MSM-A	System	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.9	
MSM-B	System	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
MSM-A	GNSS_cpuiif	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MSM-A	GNSS_ctrlif	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MSM-A	GNSS_esmi	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MSM-A	GNSS_fabric	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MSM-A	GNSS_mac_10g	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MSM-A	GNSS_pbusmux	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MSM-A	GNSS_pktengine	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MSM-A	GNSS_pktif	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MSM-A	GNSS_switch	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MSM-A	aaa	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.4	0.82
MSM-A	acl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.37
MSM-A	bgp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.2	0.27
MSM-A	cfgmgr	0.0	0.9	0.3	3.7	1.2	1.2	1.3	27.3	7.70
MSM-A	cli	0.0	0.0	0.0	48.3	9.6	2.5	2.1	48.3	0.51
MSM-A	devmgr	0.0	0.0	0.0	0.9	0.3	0.2	0.2	17.1	2.22
MSM-A	dirser	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	0.0
MSM-A	dosprotect	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	0.20
MSM-A	eaps	1.9	0.9	0.4	0.0	0.0	0.0	0.0	8.4	2.40
MSM-A	edp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.2	0.99
MSM-A	elrp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.4	0.44
MSM-A	ems	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.2	1.1
MSM-A	epm	0.0	0.0	0.0	0.9	0.1	0.2	0.2	4.7	2.6
MSM-A	esrp	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.44
MSM-A	etmon	0.9	0.4	0.6	1.2	1.1	1.0	1.0	23.3	21.84
	...									

To clear the utilization history stored in the switch and reset the statistics to zero, use the following command:

```
clear cpu-monitoring {process <name>} {slot <slotid>}
```


12

VLANs

CHAPTER

This chapter includes the following sections:

- [Overview on page 525](#)
- [Configuring VLANs on the Switch on page 533](#)
- [Displaying VLAN Information on page 537](#)
- [Private VLANs on page 538](#)
- [VLAN Translation on page 556](#)

Overview

Setting up Virtual Local Area Networks (VLANs) on the switch eases many time-consuming tasks of network administration while increasing efficiency in network operations.



NOTE

The software supports using IPv6 addresses, in addition to IPv4 addresses. You can configure the VLAN with an IPv4 address, IPv6 address, or both. See [Chapter 32, “IPv6 Unicast Routing,”](#) for complete information on using IPv6 addresses.

The term *VLAN* is used to refer to a collection of devices that communicate as if they were on the same physical LAN. Any set of ports (including all ports on the switch) is considered a VLAN. LAN segments are not restricted by the hardware that physically connects them. The segments are defined by flexible user groups that you create with the command line interface (CLI).

This section introduces the following topics:

- [Benefits on page 526](#)
- [Virtual Routers and VLANs on page 526](#)
- [Types of VLANs on page 526](#)
- [Default VLAN on page 532](#)
- [VLAN Names on page 533](#)

Benefits



NOTE

The system switches traffic within each VLAN using the Ethernet MAC address. The system routes traffic between two VLANs using the IP addresses.

Implementing VLANs on your networks has the following advantages:

- VLANs help to control traffic—With traditional networks, broadcast traffic that is directed to all network devices, regardless of whether they require it, causes congestion. VLANs increase the efficiency of your network because each VLAN can be set up to contain only those devices that must communicate with each other.
- VLANs provide extra security—Devices within each VLAN can communicate only with member devices in the same VLAN. If a device in VLAN *Marketing* must communicate with devices in VLAN *Sales*, the traffic must cross a routing device.
- VLANs ease the change and movement of devices—With traditional networks, network administrators spend much of their time dealing with moves and changes. If users move to a different subnetwork, the addresses of each endstation must be updated manually.

Virtual Routers and VLANs



NOTE

You can create virtual routers only on BlackDiamond X8 series switches, BlackDiamond 8000 c-, xl-, and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit X460, X480, X650 and X670 switches.

The ExtremeXOS software supports virtual routers. Each port can belong to multiple virtual routers. Ports can belong to different VLANs that are in different virtual routers.

If you do not specify a virtual router when you create a VLAN, the system creates that VLAN in the default virtual router (VR-Default). The management VLAN is always in the management virtual router (VR-Mgmt).

After you create virtual routers, the ExtremeXOS software allows you to designate one of these virtual routers as the domain in which all your subsequent configuration commands, including VLAN commands, are applied. After you create virtual routers, ensure that you are creating each VLAN in the desired virtual router domain. Also, ensure that you are in the correct virtual router domain before you begin modifying each VLAN.

For information on configuring and using virtual routers, see [Chapter 16, “Virtual Routers.”](#)

Types of VLANs

This section introduces the following types of VLANs:

- [Port-Based VLANs on page 527](#)
- [Tagged VLANs on page 528](#)
- [Protocol-Based VLANs on page 530](#)

**NOTE**

You can have netlogin dynamic VLANs and, on the Summit family of switches and BlackDiamond 8800 series switches only, netlogin MAC-based VLANs. See [Chapter 21, “Network Login,”](#) for complete information on netlogin.

VLANs can be created according to the following criteria:

- Physical port
- IEEE 802.1Q tag
- Ethernet, LLC SAP, or LLC/SNAP Ethernet protocol type
- A combination of these criteria

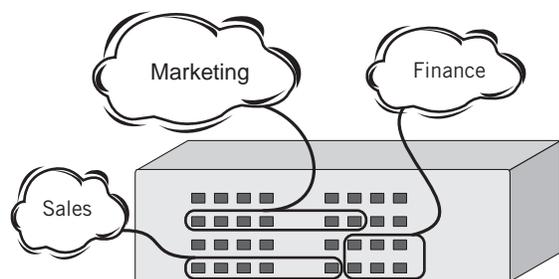
Port-Based VLANs

In a port-based VLAN, a VLAN name is given to a group of one or more ports on the switch.

At boot-up, all ports are members of the port-based VLAN *default*. Before you can add any port to another port-based VLAN, you must remove it from the default VLAN, unless the new VLAN uses a protocol other than the default protocol *any*. A port can be a member of only one port-based VLAN.

On the Extreme Networks switch in [Figure 53](#), ports 9 through 14 are part of VLAN *Marketing*; ports 25 through 29 are part of VLAN *Sales*; and ports 21 through 24 and 30 through 32 are in VLAN *Finance*.

Figure 53: Example of a Port-Based VLAN on an Extreme Networks Switch



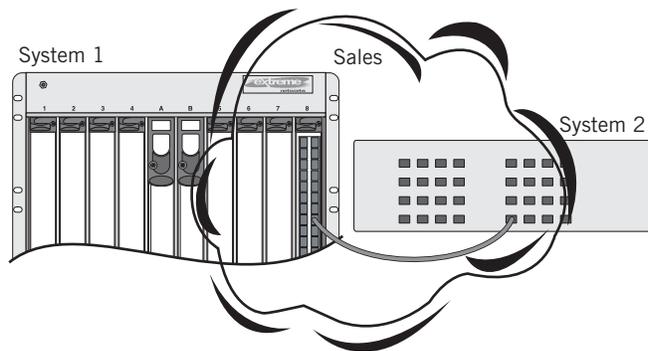
EX_060

For the members of different IP VLANs to communicate, the traffic must be routed by the switch, even if the VLANs are physically part of the same I/O module. This means that each VLAN must be configured as a router interface with a unique IP address.

Spanning Switches with Port-Based VLANs. To create a port-based VLAN that spans two switches, you must do two things:

- 1 Assign the port on each switch to the VLAN.
- 2 Cable the two switches together using one port on each switch per VLAN.

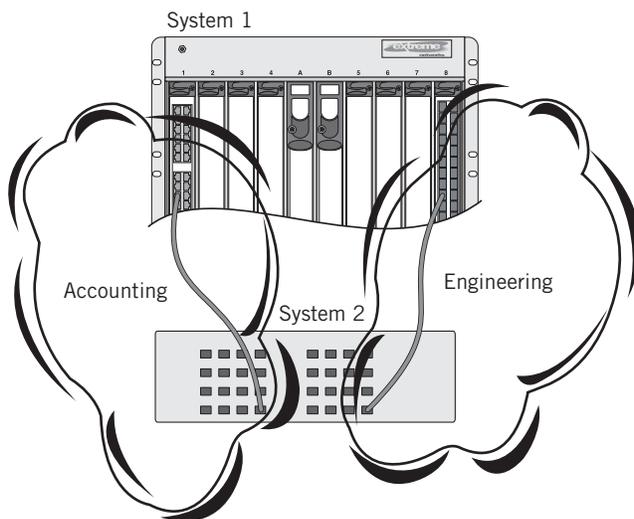
[Figure 54](#) illustrates a single VLAN that spans a BlackDiamond switch and another Extreme Networks switch. All ports on the system 1 switch belong to VLAN *Sales*. Ports 1 through 29 on the system 2 switch also belong to VLAN *Sales*. The two switches are connected using slot 8, port 4 on system 1 (the BlackDiamond switch), and port 29 on system 2 (the other switch).

Figure 54: Single Port-based VLAN Spanning Two Switches

EX_061

To create multiple VLANs that span two switches in a port-based VLAN, a port on system 1 must be cabled to a port on system 2 for *each* VLAN you want to have span across the switches. At least one port on each switch must be a member of the corresponding VLANs, as well.

Figure 55 illustrates two VLANs spanning two switches. On system 2, ports 25 through 29 are part of VLAN *Accounting*; ports 21 through 24 and ports 30 through 32 are part of VLAN *Engineering*. On system 1, all ports on slot 1 are part of VLAN *Accounting*; all ports on slot 8 are part of VLAN *Engineering*.

Figure 55: Two Port-based VLANs Spanning Two Switches

EX_063

VLAN *Accounting* spans system 1 and system 2 by way of a connection between system 2, port 29 and system 1, slot 1, port 6. VLAN *Engineering* spans system 1 and system 2 by way of a connection between system 2, port 32, and system 1, slot 8, port 6.

Using this configuration, you can create multiple port-based VLANs that span multiple switches, in a daisy-chained fashion. Each switch must have a dedicated port for each VLAN. Each dedicated port must be connected to a port that is a member of its VLAN on the next switch.

Tagged VLANs

Tagging is a process that inserts a marker (called a *tag*) into the Ethernet frame. The tag contains the identification number of a specific VLAN, called the *VLANid* (valid numbers are 1 to 4094).



NOTE

The use of 802.1Q tagged packets may lead to the appearance of packets slightly bigger than the current IEEE 802.3/Ethernet maximum of 1,518 bytes. This may affect packet error counters in other devices and may also lead to connectivity problems if non-802.1Q bridges or routers are placed in the path.

Uses of Tagged VLANs. Tagging is most commonly used to create VLANs that span switches. The switch-to-switch connections are typically called *trunks*. Using tags, multiple VLANs can span multiple switches using one or more trunks. In a port-based VLAN, each VLAN requires its own pair of trunk ports, as shown in [Figure 55](#). Using tags, multiple VLANs can span two switches with a single trunk.

Another benefit of tagged VLANs is the ability to have a port be a member of multiple VLANs. This is particularly useful if you have a device (such as a server) that must belong to multiple VLANs. The device must have a *Network Interface Card (NIC)* that supports IEEE 802.1Q tagging.

A single port can be a member of only one port-based VLAN. All additional VLAN membership for the port must be accompanied by tags.

Assigning a VLAN Tag. Each VLAN may be assigned an 802.1Q VLAN tag. As ports are added to a VLAN with an 802.1Q tag defined, you decide whether each port uses tagging for that VLAN. The default mode of the switch is to have all ports assigned to the VLAN named *default* with an 802.1Q VLAN tag (VLANid) of 1 assigned.

Not all ports in the VLAN must be tagged. As traffic from a port is forwarded out of the switch, the switch determines (in real time) if each destination port should use tagged or untagged packet formats for that VLAN. The switch adds and strips tags, as required, by the port configuration for that VLAN.

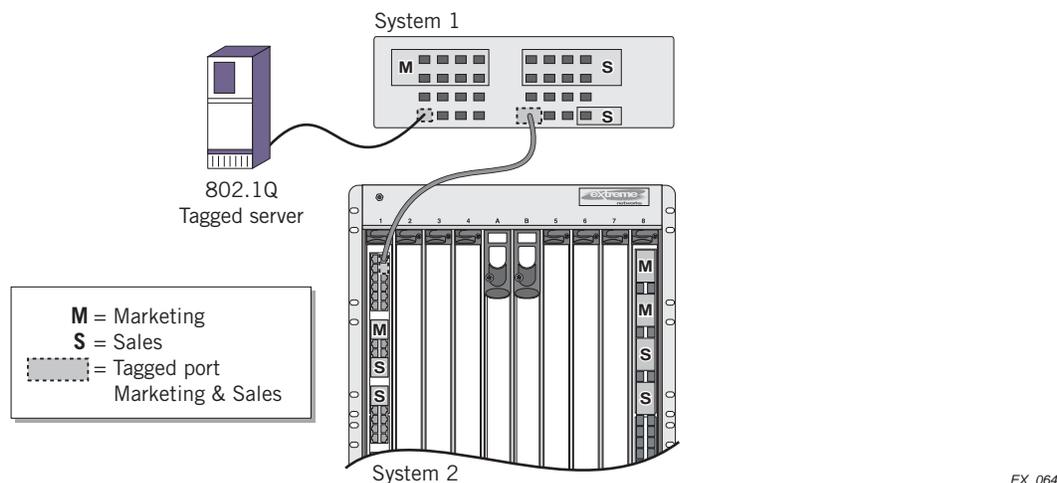


NOTE

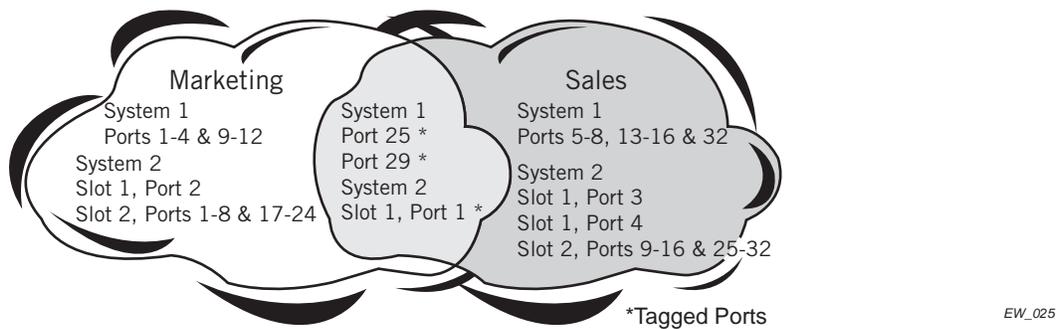
Packets arriving tagged with a VLANid that is not configured on a port are discarded.

[Figure 56](#) illustrates the physical view of a network that uses tagged and untagged traffic.

Figure 56: Physical Diagram of Tagged and Untagged Traffic



[Figure 57](#) is a logical diagram of the same network.

Figure 57: Logical Diagram of Tagged and Untagged Traffic

In [Figure 56](#) and [Figure 57](#):

- The trunk port on each switch carries traffic for both VLAN *Marketing* and VLAN *Sales*.
- The trunk port on each switch is tagged.
- The server connected to port 25 on system 1 has a NIC that supports 802.1Q tagging.
- The server connected to port 25 on system 1 is a member of both VLAN *Marketing* and VLAN *Sales*.
- All other stations use untagged traffic.

As data passes out of the switch, the switch determines if the destination port requires the frames to be tagged or untagged. All traffic coming from and going to the server is tagged. Traffic coming from and going to the trunk ports is tagged. The traffic that comes from and goes to the other stations on this network is not tagged.

Mixing Port-Based and Tagged VLANs. You can configure the switch using a combination of port-based and tagged VLANs. A given port can be a member of multiple VLANs, with the stipulation that only one of its VLANs uses untagged traffic. In other words, a port can simultaneously be a member of one port-based VLAN and multiple tag-based VLANs.



NOTE

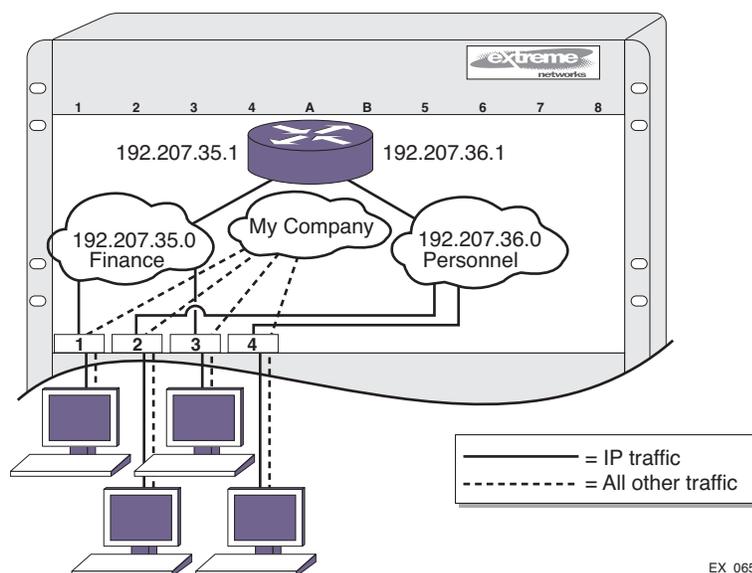
For the purposes of VLAN classification, packets arriving on a port with an 802.1Q tag containing a VLANid of 0 are treated as untagged.

Protocol-Based VLANs

Protocol-based VLANs enable you to define a packet filter that the switch uses as the matching criteria to determine if a particular packet belongs to a particular VLAN.

Protocol-based VLANs are most often used in situations where network segments contain hosts running multiple protocols. For example, in [Figure 58](#), the hosts are running both the IP and NetBIOS protocols.

The IP traffic has been divided into two IP subnets, 192.207.35.0 and 192.207.36.0. The subnets are internally routed by the switch. The subnets are assigned different VLAN names, *Finance* and *Personnel*, respectively. The remainder of the traffic belongs to the VLAN named *MyCompany*. All ports are members of the VLAN *MyCompany*.

Figure 58: Protocol-Based VLANs

EX_065

The following sections provide information on using protocol-based VLANs:

- [Predefined Protocol Filters on page 531](#)
- [Defining Protocol Filters on page 531](#)
- [Configuring a VLAN to Use a Protocol Filter on page 532](#)
- [Deleting a Protocol Filter on page 532](#)

Predefined Protocol Filters. The following protocol filters are predefined on the switch:

- IP (IPv4)
- IPv6 (11.2 IPv6)
- MPLS
- IPX
- NetBIOS
- DECNet
- IPX_8022
- IPX_SNAP
- AppleTalk

Defining Protocol Filters. If necessary, you can define a customized protocol filter by specifying EtherType, Logical Link Control (LLC), or Subnetwork Access Protocol (SNAP). Up to six protocols can be part of a protocol filter. To define a protocol filter:

1 Create a protocol using the following command:

```
create protocol <name>
```

For example:

```
create protocol fred
```

The protocol name can have a maximum of 32 characters.

2 Configure the protocol using the following command:

```
configure protocol <name> add [etype | llc | snap] <hex> {[etype | llc | snap]
<hex>}
```

Supported protocol types include:

- `etype`—EtherType

The values for `etype` are four-digit hexadecimal numbers taken from a list maintained by the IEEE. This list can be found at the following URL:

<http://standards.ieee.org/regauth/ethertype/index.html>

- `llc`—LLC Service Advertising Protocol (SAP)

The values for `llc` are four-digit hexadecimal numbers that are created by concatenating a two-digit LLC Destination SAP (DSAP) and a two-digit LLC Source SAP (SSAP).

- `snap`—EtherType inside an IEEE SNAP packet encapsulation

The values for `snap` are the same as the values for `etype`, described previously.

For example:

```
configure protocol fred add llc feff
configure protocol fred add snap 9999
```

A maximum of 15 protocol filters, each containing a maximum of 6 protocols, can be defined. No more than 7 protocols can be active and configured for use.

**NOTE**

For more information on SNAP for Ethernet protocol types, see TR 11802-5:1997 (ISO/IEC) [ANSI/IEEE std. 802.1H, 1997 Edition].

Configuring a VLAN to Use a Protocol Filter. To configure a VLAN to use a protocol filter, use the following command:

```
configure {vlan} <vlan_name> protocol <protocol_name>
```

Deleting a Protocol Filter. If a protocol filter is deleted from a VLAN, the VLAN is assigned a protocol filter of *any*. You can continue to configure the VLAN. However, no traffic is forwarded to the VLAN until a protocol is assigned to it.

Precedence of Tagged Packets Over Protocol Filters. If a VLAN is configured to accept tagged packets on a particular port, incoming packets that match the tag configuration take precedence over any protocol filters associated with the VLAN.

Default VLAN

The default switch configuration includes one default VLAN that has the following properties:

- The VLAN name is *default*.
- It contains all the ports on a new or initialized switch.
- The default VLAN is untagged on all ports. It has an internal VLANid of 1; this value is user-configurable.

VLAN Names

VLAN names must conform to the guidelines listed in “Object Names” on page 42.

VLAN names can be specified using the tab key for command completion.

VLAN names are locally significant. That is, VLAN names used on one switch are only meaningful to that switch. If another switch is connected to it, the VLAN names have no significance to the other switch.



NOTE

Extreme Networks recommends that you use VLAN names consistently across your entire network.

You must use mutually exclusive names for the following:

- VLANs
- VMANs
- IPv6 tunnels
- SVLANs
- CVLANs
- BVLANS

Configuring VLANs on the Switch

This section describes the following VLAN configuration topics:

- [VLAN Configuration Overview on page 533](#)
- [Creating and Deleting VLANs on page 534](#)
- [Managing a VLAN IP Address on page 534](#)
- [Configuring a VLAN Tag on page 535](#)
- [Adding and Removing Ports from a VLAN on page 535](#)
- [Adding and Removing VLAN Descriptions on page 535](#)
- [Renaming a VLAN on page 535](#)
- [Enabling and Disabling VLANs on page 535](#)
- [VLAN Configuration Examples on page 536](#)

VLAN Configuration Overview

This following procedure provides an overview of VLAN creation and configuration:

1 Create and name the VLAN using the following command:

```
create vlan <vlan_name> {description <vlan-description>} {vr <name>}
```

2 If needed, assign an IP address and mask (if applicable) to the VLAN as described in “Managing a VLAN IP Address” on page 534.

- 3 If any ports in this VLAN will use a tag, assign a VLAN tag using the following command:

```
configure {vlan} <vlan_name> tag <tag> {remote-mirroring}
```

- 4 Assign one or more ports to the VLAN with the following command:

```
configure {vlan} <vlan_name> add ports [<port_list> | all] {tagged | untagged}
{{stpd} <stpd_name>} {dot1d | emistp | pvst-plus}}
```

As you add each port to the VLAN, decide if the port will use an 802.1Q tag.

- 5 For the management VLAN on the switch, configure the default IP route for virtual router *VR-Mgmt*.

**NOTE**

See [Chapter 31, “IPv4 Unicast Routing,”](#) for information on configuring default IP routes or adding secondary IP addresses to VLANs.

Creating and Deleting VLANs

To create a VLAN, use the following command:

```
create vlan <vlan_name> {description <vlan-description>} {vr <name>}
```

To delete a VLAN, use the following command:

```
delete vlan <vlan_name>
```

Managing a VLAN IP Address

**NOTE**

If you plan to use this VLAN as a control VLAN for an EAPS domain, do NOT assign an IP address to the VLAN.

To configure an IP address and mask for a VLAN, use the following command:

```
configure {vlan} <vlan_name> ipaddress [<ipaddress> {<ipNetmask>} | ipv6-link-local |
{eui64} <ipv6_address_mask>]
```

**NOTE**

Each IP address and mask assigned to a VLAN must represent a unique IP subnet. You cannot configure the same IP subnet on different VLANs on the same virtual router.

**NOTE**

The software supports using IPv6 addresses, in addition to IPv4 addresses. You can configure the VLAN with an IPv4 address, IPv6 address, or both. See [Chapter 32, “IPv6 Unicast Routing,”](#) for complete information on using IPv6 addresses.

To remove an IP address and mask for a VLAN, use the following command:

```
unconfigure {vlan} <vlan_name> ipaddress {<ipv6_address_mask>}
```

Configuring a VLAN Tag

To configure a VLAN, use the following command:

```
configure {vlan} <vlan_name> tag <tag> {remote-mirroring}
```

Adding and Removing Ports from a VLAN

To add ports to a VLAN, use the following command:

```
configure {vlan} <vlan_name> add ports [<port_list> | all] {tagged | untagged} {{stpd}
<stpd_name>} {dot1d | emistp | pvst-plus}}
```

The system returns the following message if the ports you are adding are already EAPS primary or EAPS secondary ports:

```
WARNING: Make sure Vlan1 is protected by EAPS, Adding EAPS ring ports to a VLAN could
cause a loop in the network.
```

```
Do you really want to add these ports? (y/n)
```

To remove ports from a VLAN, use the following command:

```
configure {vlan} <vlan_name> delete ports [all | <port_list>]
```

Adding and Removing VLAN Descriptions

A VLAN description is a string of up to 64 characters that you can configure to describe the VLAN. It is displayed by several `show vlan` commands and can be read by using SNMP to access the VLAN's ifAlias MIB object.

To add a description to a VLAN, use the following command:

```
configure {vlan} <vlan_name> description [<vlan-description> | none]
```

To remove a description from a VLAN, use one of the following commands:

```
configure {vlan} <vlan_name> description none
```

```
unconfigure {vlan} <vlan_name> description
```

Renaming a VLAN

To rename an existing VLAN, use the following command:

```
configure {vlan} <vlan_name> name <name>
```

The following rules apply to renaming VLANs:

- You cannot change the name of the default VLAN.
- You cannot create a new VLAN named *default*.

Enabling and Disabling VLANs

You can enable or disable individual VLANs. The default setting is that all VLANs are enabled.

Consider the following guidelines before you disable a VLAN:

- Disabling a VLAN stops *all* traffic on all ports associated with the specified VLAN.
- You cannot disable any VLAN that is running any Layer 2 protocol traffic.

When you attempt to disable a VLAN running Layer 2 protocol traffic (for example, the VLAN *Accounting*), the system returns a message similar to the following:

```
VLAN accounting cannot be disabled because it is actively use by an L2 Protocol
```

- You can disable the default VLAN; ensure that this is necessary before disabling the default VLAN.
- You *cannot* disable the management VLAN.
- You *cannot* bind Layer 2 protocols to a disabled VLAN.
- You *can* add ports to and delete ports from a disabled VLAN.

To disable a VLAN, issue the following CLI command:

```
disable vlan <vlan_name>
```

After you have disabled a VLAN and want to re-enable that VLAN, use the following CLI command:

```
enable vlan <vlan_name>
```

VLAN Configuration Examples



NOTE

To add an untagged port to a VLAN you create, you must first delete that port from the *default* vlan. If you attempt to add an untagged port to a VLAN before deleting it from the default VLAN, you see the following error message:

```
Error: Protocol conflict when adding untagged port 1:2. Either add this port as tagged or assign another protocol to this VLAN.
```

The following modular switch example creates a port-based VLAN named *accounting*:

```
create vlan accounting
configure accounting ipaddress 132.15.121.1
configure default delete port 2:1-2:3,2:6,4:1,4:2
configure accounting add port 2:1-2:3,2:6,4:1,4:2
```



NOTE

Because VLAN names are unique, you do not need to enter the keyword `vlan` after you have created the unique VLAN name. You can use the VLAN name alone (unless you are also using this name for another category such as STPD or EAPS, in which case Extreme Networks recommends including the keyword `vlan`).

The following stand-alone switch example creates a port-based VLAN named *development* with an IPv6 address:

```
create vlan development
configure development ipaddress 2001:0DB8::8:800:200C:417A/64
configure default delete port 1-3
configure development add port 1-3
```

The following modular switch example creates a protocol-based VLAN named *ipsales*. Slot 5, ports 6 through 8, and slot 6, ports 1, 3, and 4-6 are assigned to the VLAN. In this example, you can add

untagged ports to a new VLAN without first deleting them from the default VLAN, because the new VLAN uses a protocol other than the default protocol.

```
create vlan ipsales
configure ipsales protocol ip
configure ipsales add port 5:6-5:8,6:1,6:3-6:6
```

The following modular switch example defines a protocol filter, *myprotocol* and applies it to the VLAN named *myvlan*. This is an example only, and has no real-world application.

```
create protocol myprotocol
configure protocol myprotocol add etype 0xf0f0
configure protocol myprotocol add etype 0xffff
create vlan myvlan
configure myvlan protocol myprotocol
```

To disable the protocol-based VLAN (or any VLAN) in the above example, use the following command:

```
disable vlan myprotocol
```

To re-enable the VLAN, use the following command:

```
enable vlan myprotocol
```

Displaying VLAN Information

To display general VLAN settings and information, use the following commands:

```
show vlan {virtual-router <vr-name>}
show {vlan} <vlan_name> {ipv4 | ipv6}
show vlan [tag <tag> | detail] {ipv4 | ipv6}
show vlan description
show vlan {<vlan_name>} statistics {no-refresh}
```



NOTE

To display IPv6 information, you must use either the `show vlan detail` command or `show vlan` command with the name of the specified VLAN.

To display the VLAN information for other ExtremeXOS software features, use the following commands:

```
show {vlan} <vlan_name> dhcp-address-allocation
show {vlan} <vlan_name> dhcp-config
show {vlan} <vlan_name> eaps
show {vlan} <vlan_name> security
show {vlan} <vlan_name> stpd
```

You can display additional useful information on VLANs configured with IPv6 addresses by issuing the `show ipconfig ipv6 vlan <vlan_name>` command.

To display protocol information, use the following command:

```
show protocol {<name>}
```

Private VLANs

The section covers the following Private VLAN (PVLAN) topics:

- [PVLAN Overview on page 538](#)
- [Configuring PVLANS on page 546](#)
- [Displaying PVLAN Information on page 550](#)
- [PVLAN Configuration Example 1 on page 551](#)
- [PVLAN Configuration Example 2 on page 553](#)

PVLAN Overview

PVLANS offer the following features:

- VLAN translation
- VLAN isolation



NOTE

PVLAN features are supported only on the platforms listed for this feature in the license tables in [Appendix A, “Feature License Requirements.”](#)

The following sections introduce PVLAN features and components:

- [VLAN Translation in a PVLAN on page 538](#)
- [VLAN Isolation on page 540](#)
- [PVLAN Components on page 541](#)
- [PVLAN Support over Multiple Switches on page 542](#)
- [Extending Network and Subscriber VLANs to Other Switches on page 543](#)
- [MAC Address Management in a PVLAN on page 544](#)
- [Layer 3 Communications on page 545](#)
- [PVLAN Limitations on page 545](#)

VLAN Translation in a PVLAN

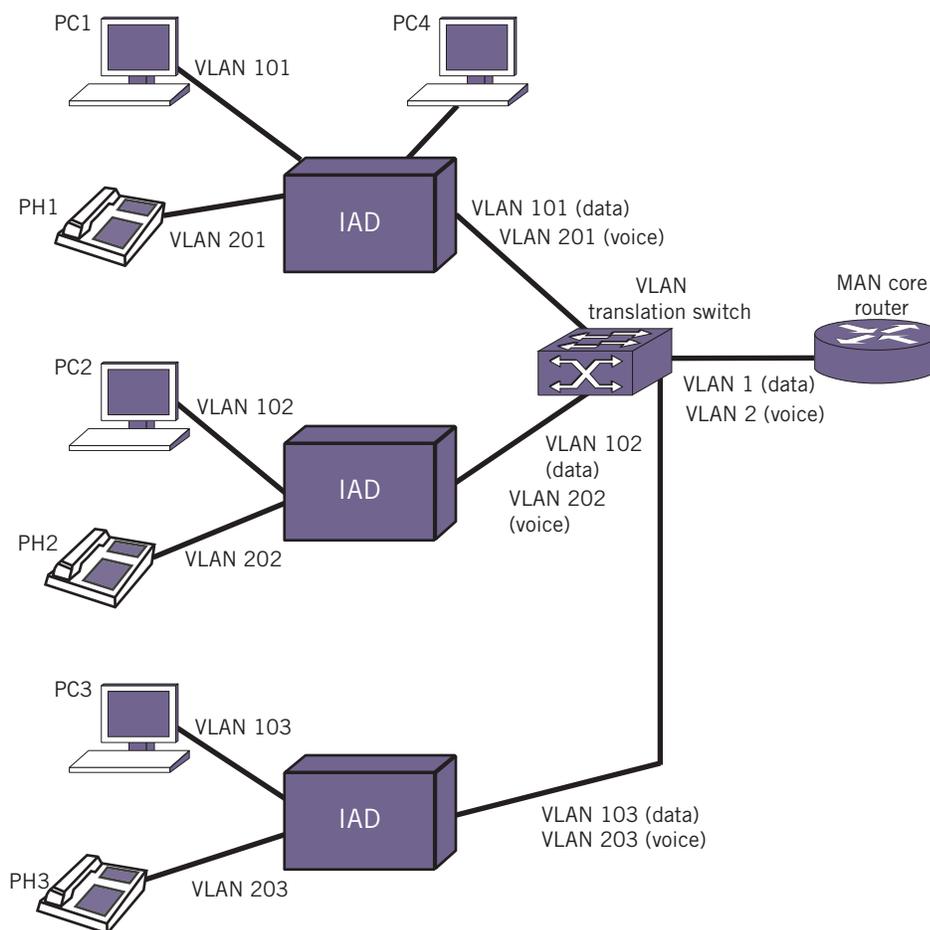
VLAN translation provides the ability to translate the 802.1Q tags for several VLANs into a single VLAN tag. VLAN translation is an optional component in a PVLAN.

VLAN translation allows you to aggregate Layer 2 VLAN traffic from multiple clients into a single uplink VLAN, improving VLAN scaling. [Figure 59](#) shows an application of VLAN translation.



NOTE

The VLAN translation feature described in [“VLAN Translation” on page 556](#) is provided for those who are already familiar with the ExtremeWare VLAN translation feature. If you have time to use the PVLAN implementation and do not have scripts that use the ExtremeWare commands, we suggest that you use the PVLAN feature, as it provides the same functionality with additional features.

Figure 59: VLAN Translation Application

EX_vlan_0031

In the figure, VLANs 101, 102, and 103 are *subscriber* VLANs that carry data traffic while VLANs 201, 202, and 203 are subscriber VLANs that carry voice traffic. The voice and data traffic are combined on integrated access devices (IADs) that connect to the VLAN translation switch. Each of the three clusters of phones and PCs uses two VLANs to separate the voice and data traffic. As the traffic is combined, the six VLANs are translated into two *network* VLANs, VLAN1 and VLAN2. This simplifies administration, and scales much better for large installations.

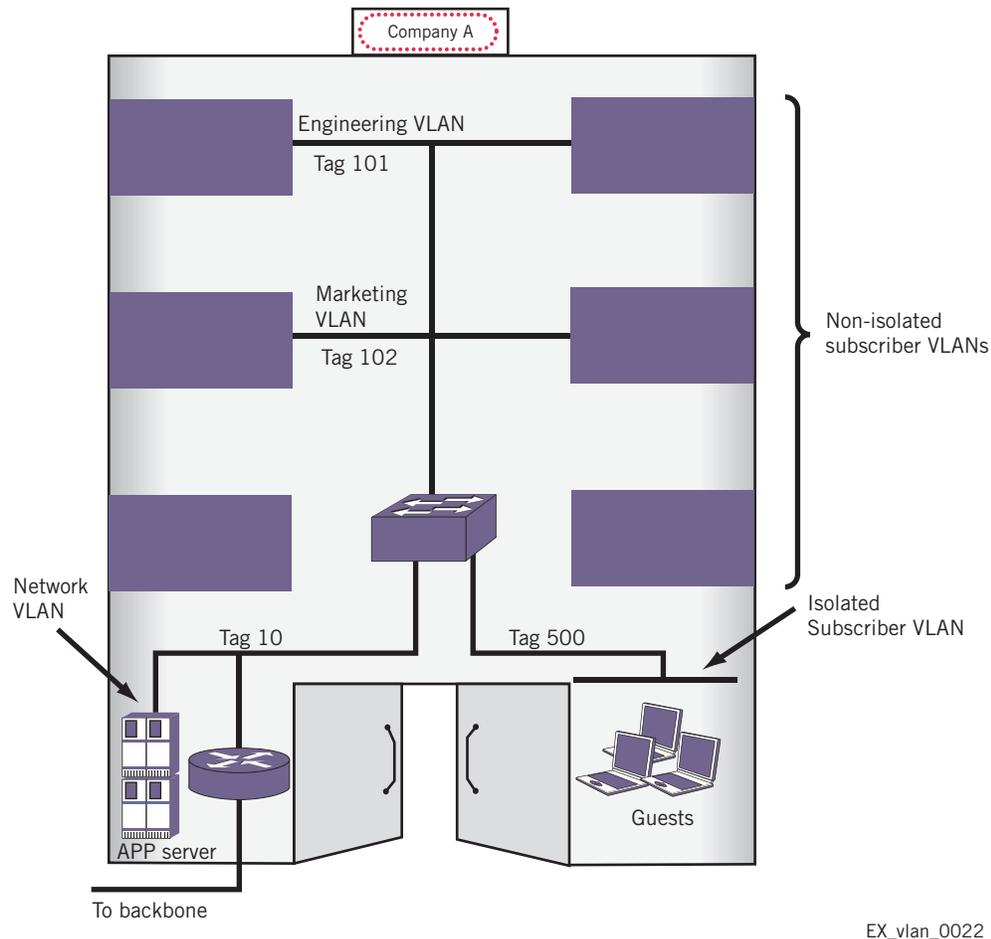
Conceptually, this is very similar to Layer 3 VLAN aggregation (superVLANs and subVLANs). The primary differences between these two features are:

- VLAN translation is strictly a Layer 2 feature.
- VLAN translation does not allow communication between the subscriber VLANs.

VLAN Isolation

VLAN isolation provides Layer 2 isolation between the ports in a VLAN. [Figure 60](#) shows an application of VLAN isolation.

Figure 60: VLAN Isolation Application

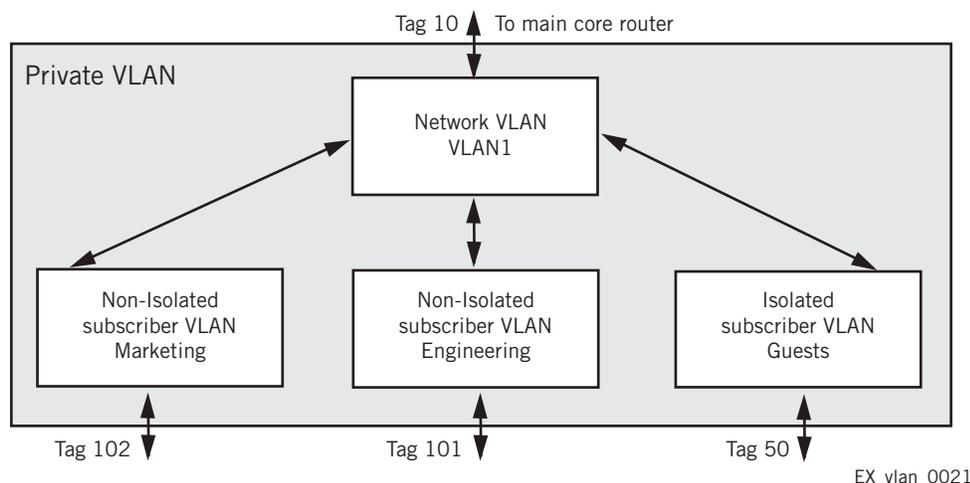


In [Figure 60](#), ports in the Guest VLAN have access to services on the network VLAN, but Guest VLAN ports cannot access other Guest VLAN ports over Layer 2 (or the Marketing or Engineering VLANs). This provides port-to-port security at Layer 2.

PVLAN Components

Figure 61 shows the logical components that support PVLAN configuration in a switch.

Figure 61: Private VLAN Switch Components



There is one *network VLAN* in each PVLAN. Ports within a network VLAN, called *network ports*, can communicate with all VLAN ports in the PVLAN. Network devices that connect to the network VLAN ports are considered to be on the *network side* of the switch.

The network VLAN aggregates the uplink traffic from the other VLANs, called *subscriber VLANs*, for egress communications on a network VLAN port. A network port can serve only one PVLAN, but it can serve one or more subscriber VLANs. Ingress communications on the network VLAN port are distributed to the appropriate subscriber VLANs for distribution to the appropriate ports. Devices that connect to subscriber VLAN ports are considered to be on the *subscriber side* of the switch.

Tag translation within the PVLAN is managed at the egress ports. To enable tag translation for uplink traffic from the subscriber VLANs, you must enable tag translation on the appropriate network VLAN port. Tag translation is automatically enabled on subscriber VLAN egress ports when the subscriber VLAN is created and the port is added to the VLAN as *tagged*. Egress traffic from a subscriber VLAN is always tagged with the subscriber VLAN tag when the port is configured as tagged.

A non-isolated subscriber VLAN is basically a standard VLAN that can participate in tag translation through the network VLAN when VLAN translation is enabled on the network VLAN port. You can choose to not translate tags on a network VLAN port, but this is generally used only for extending a PVLAN to another switch. A non-isolated subscriber VLAN that does not use tag translation is functionally equivalent to a regular VLAN, so it is better to create non-isolated VLANs only when you plan to use tag translation.

Ports in a non-isolated VLAN can communicate with other ports in the same VLAN, ports in the network VLAN, and destinations on the network side of the switch. As with standard VLANs, non-isolated ports cannot communicate through Layer 2 with ports in other subscriber VLANs.

In Figure 60, the Engineering and Marketing VLANs are configured as *non-isolated subscriber VLANs*, which means that they act just like traditional VLANs, and they can participate in tag translation when VLAN translation is enabled on a network VLAN port that leads to network side location.

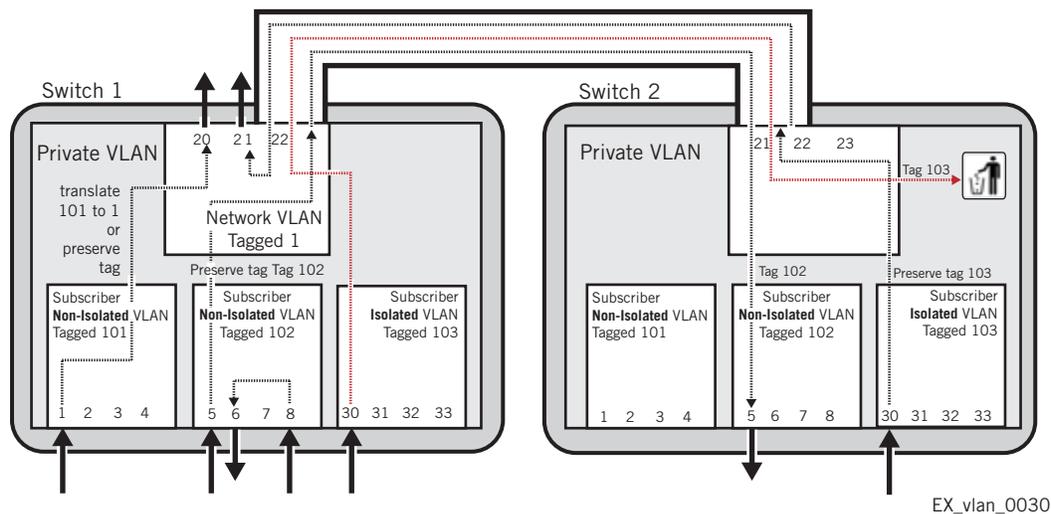
VLAN isolation within the PVLAN is established by configuring a VLAN to be an *isolated subscriber VLAN* and adding ports to the isolated VLAN. Unlike normal VLANs, ports in an isolated VLAN cannot communicate with other ports in the same VLAN over Layer 2 or Layer 3. The ports in an

isolated VLAN can, however, communicate with Layer 2 devices on the network side of the PVLAN through the network VLAN. When the network VLAN egress port is configured for tag translation, isolated VLAN ports also participate in uplink tag translation. When isolated subscriber VLAN ports are configured as *tagged*, egress packets are tagged with the isolated VLAN tag. As with standard VLANs and non-isolated VLANs, isolated ports cannot communicate through Layer 2 with ports in other subscriber VLANs.

PVLAN Support over Multiple Switches

A PVLAN can span multiple switches. [Figure 62](#) shows a PVLAN that is configured to operate on two switches.

Figure 62: Private VLAN Support on Multiple Switches



A PVLAN can span many switches. For simplicity, [Figure 62](#) shows only two switches, but you can extend the PVLAN to additional switches by adding connections between the network VLANs in each switch. The ports that connect two PVLAN switches must be configured as regular tagged ports. The network and subscriber VLANs on each switch must be configured with the same tags.



NOTE

Although using the same VLAN names on all PVLAN switches might make switch management easier, there is no software requirement to match the VLAN names. Only the tags must match.

When a PVLAN is configured on multiple switches, the PVLAN switches function as one PVLAN switch. Subscriber VLAN ports can access the network VLAN ports on any of the PVLAN switches, and non-isolated VLAN ports can communicate with ports in the same VLAN that are located on a different physical switch. An isolated VLAN can span multiple switches and maintain isolation between the VLAN ports.

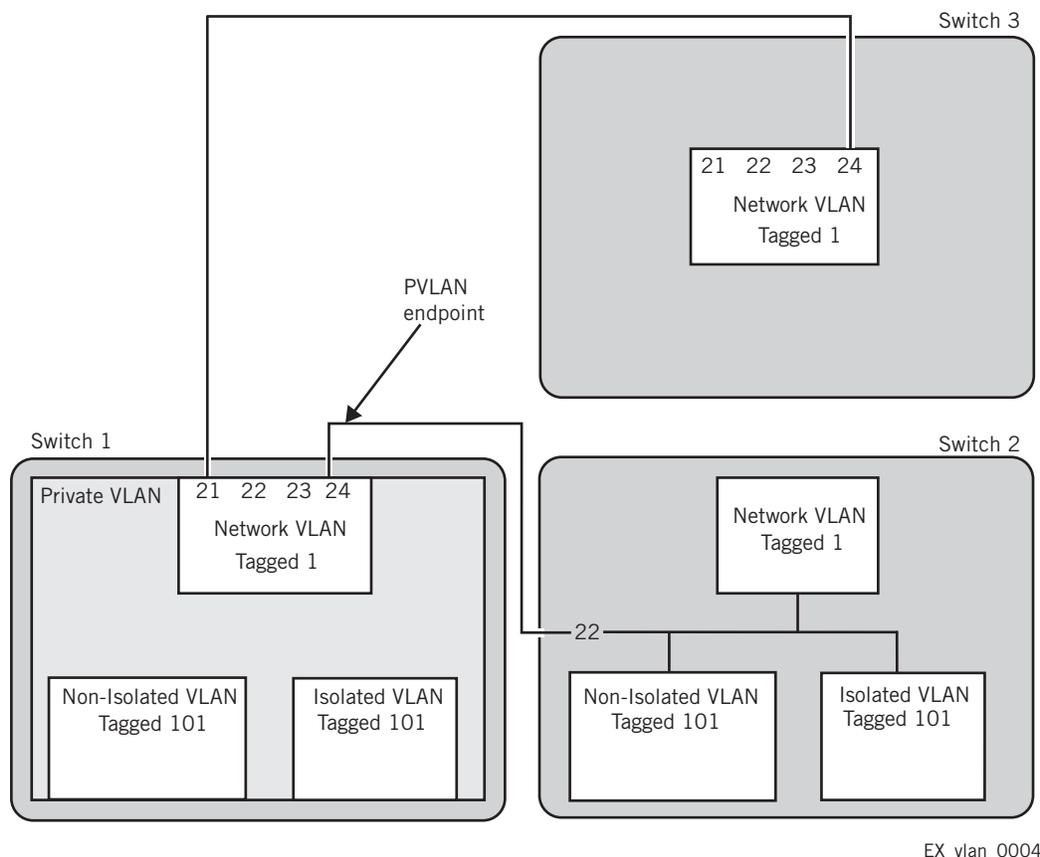
The network and subscriber VLANs can be extended to other switches that are not configured for the PVLAN (as described in [“Extending Network and Subscriber VLANs to Other Switches”](#) on page 543). The advantage to extending the PVLAN is that tag translation and VLAN isolation is supported on the additional switch or switches.

Extending Network and Subscriber VLANs to Other Switches

A network or subscriber VLAN can be extended to additional switches without a PVLAN configuration on the additional switches. You might want to do this to connect to existing servers, switches, or other network devices. You probably do not want to use this approach to support clients, as tag translation and VLAN isolation are not supported unless the PVLAN is configured on all PVLAN switches as described in “PVLAN Support over Multiple Switches” on page 542.

Figure 63 illustrates PVLAN connections to switches outside the PVLAN.

Figure 63: Private VLAN Connections to Switches Outside the PVLAN



In Figure 63, Switch 1, Network VLAN Port 21, connects to a Switch 3 port that only supports the Network VLAN. In this configuration, the Network VLAN Port 21 on Switch 1 is configured as “translated,” which translates subscriber VLAN tags to the network VLAN tag for access to the Network VLAN extension on Switch 3. Switch 3, Port 24 is configured as tagged and only accepts traffic with the Network VLAN Tag. Switch 3 serves as an extension of the Network VLAN and can be used to connect to network devices such as servers or an internet gateway.

Switch 2, Port 22 supports the Network, NonIsolated, and Isolated VLANs, but no PVLAN is configured. Because Port 22 supports multiple VLANs that are part of the PVLAN, and because these Switch 2 VLANs are not part of the PVLAN, Switch 1, Port 24, must be configured as a PVLAN endpoint, which establishes the PVLAN boundary. Switch 2, port 22, is configured as a regular tagged VLAN port.

For most applications, it would be better to extend the PVLAN to Switch 2 so that the PVLAN features are available to the Switch 2 VLANs. The configuration of Switch 2 behaves as follows:

- The Switch 2 NonIsolated VLAN ports can communicate with the NonIsolated VLAN ports on Switch 1, but they cannot participate in VLAN translation.
- The Switch 2 Isolated VLAN ports can communicate with other Switch 2 Isolated VLAN ports.
- The Switch 2 Isolated VLAN ports cannot participate in VLAN translation.
- The Switch 2 Isolated VLAN ports can receive broadcast and multicast info for the Isolated VLAN.
- Traffic is allowed from the Switch 1 Isolated VLAN ports to the Switch 2 Isolated VLAN ports.

MAC Address Management in a PVLAN

Each device that connects to a PVLAN must have a unique MAC address within the PVLAN. Each MAC address learned in a PVLAN requires multiple FDB entries. For example, each MAC address learned in a non-isolated subscriber VLAN requires two FDB entries, one for the subscriber VLAN and one for the network VLAN. The additional FDB entries for a PVLAN are marked with the P flag in the `show fdb` command display.

The following sections describe the FDB entries created for the PVLAN components and how to estimate the impact of a PVLAN on the FDB table:

- [Non-Isolated Subscriber VLAN on page 544](#)
- [Isolated Subscriber VLAN on page 544](#)
- [Network VLAN on page 544](#)
- [Calculating the Total FDB Entries for a PVLAN on page 545](#)

Non-Isolated Subscriber VLAN. When a MAC address is learned on a non-isolated subscriber VLAN port, two entries are added to the FDB table:

- MAC address, non-isolated subscriber VLAN tag, and the port number
- MAC address, network VLAN tag, port number, and a special flag for tag translation

The network VLAN entry is used when traffic comes in from the network ports destined for an non-isolated port.

Isolated Subscriber VLAN. When a new MAC address is learned on an isolated subscriber VLAN port, two entries are added to the FDB table:

- MAC address, isolated subscriber VLAN tag, port number, and a flag that indicates that the packet should be dropped
- MAC address, network VLAN tag, port number, and a special flag for tag translation

Ports in the isolated VLAN do not communicate with one another. If a port in the isolated VLAN sends a packet to another port in the same VLAN that already has an entry in the FDB, that packet is dropped. You can verify the drop packet status of an FDB entry by using the `show fdb` command. The *D* flag indicates that packets destined for the listed address are dropped.

The network VLAN entry is used when traffic comes in from the network ports destined for an isolated port.

Network VLAN. When a new MAC address is learned on a network VLAN port, the following entry is added to the FDB table: MAC address, network VLAN tag, and port number.

For every subscriber VLAN belonging to this PVLAN, the following entry is added to the FDB table: MAC address, subscriber VLAN tag, and port number

Calculating the Total FDB Entries for a PVLAN. The following formula can be used to estimate the maximum number of FDB entries for a PVLAN:

$$FDB_{total} = [(MAC_{non-iso} + MAC_{iso}) * 2 + (MAC_{network} * (VLAN_{non-iso} + VLAN_{iso} + 1))]$$

The formula components are as follows:

- $MAC_{non-iso}$ = number of MAC addresses learned on all the non-isolated subscriber VLANs
- MAC_{iso} = number of MAC addresses learned on all the isolated subscriber VLANs
- $MAC_{network}$ = number of MAC addresses learned on the network VLAN
- $VLAN_{non-iso}$ = number of non-isolated subscriber VLANs
- $VLAN_{iso}$ = number of isolated subscriber VLANs



NOTE

The formula above estimates the worst-case scenario for the maximum number of FDB entries for a single PVLAN. If the switch supports additional PVLANS, apply the formula to each PVLAN and add the totals for all PVLANS. If the switch also support standard VLANs, there will also be FDB entries for the standard VLANs.

Layer 3 Communications

For PVLANS, the default switch configuration controls Layer 3 communications exactly as communications are controlled in Layer 2. For example, Layer 3 communications is enabled between ports in a non-isolated subscriber VLAN, and disabled between ports in an isolated subscriber VLAN. Ports in a non-isolated subscriber VLAN cannot communicate with ports in other non-isolated subscriber VLANs.

You can enable Layer 3 communications between all ports in a PVLAN. For more information, see [“Managing Layer 3 Communications in a PVLAN” on page 549](#).

PVLAN Limitations

The Private VLAN feature has the following limitations:

- Requires more FDB entries than a standard VLAN
- Within the same VR, VLAN tag duplication is not allowed
- Within the same VR, VLAN name duplication is not allowed
- Each MAC address learned in a PVLAN must be unique. A MAC address cannot exist in two or more VLANs that belong to the same PVLAN.
- MVR cannot be configured on PVLANS.
- A VMAN cannot be added to a PVLAN.
- A PBB network (BVLAN) cannot be added to a PVLAN.
- EAPS control VLANs cannot be either subscriber or network VLANs.
- EAPS can only be configured on network VLAN ports (and not on subscriber VLAN ports). To support EAPS on the network VLAN, you must add all of the VLANs in the PVLAN to the EAPS ring.

- STP can only be configured on network VLAN ports (and not on subscriber VLAN ports). To support STP on the network VLAN, you must add all of the VLANs in the PVLAN to STP.
- ESRP can only be configured on network VLAN ports (and not on subscriber VLAN ports). To support ESRP on the network VLAN, you must add all of the VLANs in the PVLAN to ESRP.
- There is no NetLogin support to add ports as translate to the network VLAN, but the rest of NetLogin and the PVLAN feature do not conflict.
- IGMP snooping is performed across the entire PVLAN, spanning all the subscriber VLANs, following the PVLAN rules. For VLANs that are not part of a PVLAN, IGMP snooping operates as normal.
- PVLAN and VPLS are not supported on the same VLAN.
- When two switches are part of the same PVLAN, unicast and multicast traffic require a tagged trunk between them that preserves tags (no tag translation).
- Subscriber VLANs in a PVLAN cannot exchange multicast data with VLANs outside the PVLAN and with other PVLANS. However, the network VLAN can exchange multicast data with VLANs outside the PVLAN and with network VLANs in other PVLANS.

**NOTE**

A maximum of 80% of 4K VLANs can be added to a PVLAN. Adding more VLANs will display the following log error: `<Error:HAL.VLAN.Error>Slot-<slot>: Failed to add egress vlan translation entry on port <port> due to "Table full"`.

An additional limitation applies to BlackDiamond 8000 series modules and Summit family switches, whether or not included in a SummitStack. If two or more member VLANs have overlapping ports (where the same ports are assigned to both VLANs), each additional VLAN member with overlapping ports must have a dedicated loopback port. To state it another way, one of the VLAN members with overlapping ports does not require a dedicated loopback port, and the rest of the VLAN members do require a single, dedicated loopback port within each member VLAN.

**NOTE**

There is a limit to the number of unique source MAC addresses on the network VLAN of a PVLAN that the switch can manage. It is advised not to exceed the value shown in the item "FDB (maximum L2 entries)" in the Supported Limits table of the ExtremeXOS Installation and Release Notes.

Configuring PVLANS

The following sections describe common PVLAN configuration tasks:

- [Creating PVLANS on page 547](#)
- [Configuring Network VLAN Ports for VLAN Translation on page 547](#)
- [Configuring Non-Isolated Subscriber VLAN Ports on page 548](#)
- [Configuring Isolated Subscriber VLAN Ports on page 548](#)
- [Configuring a PVLAN on Multiple Switches on page 549](#)
- [Configuring a Network or Subscriber VLAN Extension to Another Switch on page 549](#)
- [Adding a Loopback Port to a Subscriber VLAN on page 549](#)
- [Managing Layer 3 Communications in a PVLAN on page 549](#)

- [Deleting PVLANS on page 550](#)
- [Removing a VLAN from a PVLAN on page 550](#)
- [Deleting a Loopback Port from a Subscriber VLAN on page 550](#)

Creating PVLANS

To create a VLAN, you need to do the following:

- Create the PVLAN
- Add one VLAN to the PVLAN as a network VLAN
- Add VLANs to the PVLAN as subscriber VLANs

To create a PVLAN, use the following command:

```
create private-vlan <name> {vr <vr_name>}
```

To add a network VLAN to the PVLAN, create and configure a tagged VLAN, and then use the following command to add that network VLAN:

```
configure private-vlan <name> add network <vlan_name>
```

To add a subscriber VLAN to the PVLAN, create and configure a tagged VLAN, and then use the following command to add that subscriber VLAN:

```
configure private-vlan <name> add subscriber <vlan_name> {non-isolated} {loopback-port <port>}
```

By default, this command adds an isolated subscriber VLAN. To create a non-isolated subscriber VLAN, you must include the `non-isolated` option.

Configuring Network VLAN Ports for VLAN Translation

When subscriber VLAN traffic exits a network VLAN port, it can be untagged, tagged (with the subscriber VLAN tag), or translated (to the network VLAN tag).



NOTE

All traffic that exits a subscriber VLAN port uses the subscriber VLAN tag, unless the port is configured as untagged. There is no need to configure VLAN translation (from network to subscriber VLAN tag) on subscriber VLAN ports.

To configure network VLAN ports for VLAN translation, use the following command and specify the network VLAN and port numbers:

```
configure {vlan} <vlan_name> add ports <port_list> private-vlan translated
```

If you want to later reconfigure a port that is configured for VLAN translation so that it does not translate tags, use the following command and specify either the `tagged` or the `untagged` option:

```
configure {vlan} <vlan_name> add ports [<port_list> | all] {tagged | untagged} [{stp} {stp_name} | dot1d | emistp | pvst-plus]}
```

Configuring Non-Isolated Subscriber VLAN Ports

The process for configuring non-isolated VLAN ports requires two tasks:

- Add a VLAN to the PVLAN as a non-isolated subscriber VLAN
- Assign ports to the non-isolated subscriber VLAN

These tasks can be completed in any order, but they must both be completed before a port can participate in a PVLAN. When configuration is complete, all egress traffic from the port is translated to the VLAN tag for that non-isolated VLAN (unless the port is configured as untagged).



NOTE

To configure VLAN translation for network VLAN ports, see [“Configuring Network VLAN Ports for VLAN Translation” on page 547](#).

To add a non-isolated subscriber VLAN to the PVLAN, use the following command:

```
configure private-vlan <name> add subscriber <vlan_name> non-isolated
```

To add ports to a non-isolated VLAN (before or after it is added to the PVLAN), use the following command:

```
configure {vlan} <vlan_name> add ports [<port_list> | all] {tagged | untagged} {{stpd}
<stpd_name>} {dot1d | emistp | pvst-plus}}
```

If you specify the tagged option, egress traffic uses the non-isolated VLAN tag, regardless of the network translation configuration on any network port with which these ports communicate. Egress traffic from a non-isolated VLAN port never carries the network VLAN tag.

Configuring Isolated Subscriber VLAN Ports

When a port is successfully added to an isolated VLAN, the port is isolated from other ports in the same VLAN, and all egress traffic from the port is translated to the VLAN tag for that VLAN (unless the port is configured as untagged).



NOTE

To configure VLAN translation for network VLAN ports, see [“Configuring Network VLAN Ports for VLAN Translation” on page 547](#).

The process for configuring ports for VLAN isolation requires two tasks:

- Add a VLAN to the PVLAN as an isolated subscriber VLAN
- Assign ports to the isolated subscriber VLAN

These tasks can be completed in any order, but they must both be completed before a port can participate in an isolated VLAN.

To add an isolated subscriber VLAN to the PVLAN, use the following command:

```
configure private-vlan <name> add subscriber <vlan_name>
```

To add ports to an isolated VLAN (before or after it is added to the PVLAN), use the following command:

```
configure {vlan} <vlan_name> add ports [<port_list> | all] {tagged | untagged} {{stpd}
<stpd_name>} {dot1d | emistp | pvst-plus}}
```

If you specify the tagged option, egress traffic uses the isolated VLAN tag, regardless of the network translation configuration on any network port with which these ports communicate. Egress traffic from an isolated VLAN port never carries the network VLAN tag.

Configuring a PVLAN on Multiple Switches

To create a PVLAN that runs on multiple switches, you must configure the PVLAN on each switch and set up a connection between the network VLANs on each switch. The ports at each end of the connection must be configured as tagged ports that do not perform tag translation. To configure these types of ports, use the following command:

```
configure {vlan} <vlan_name> add ports <port_list> tagged
```

Configuring a Network or Subscriber VLAN Extension to Another Switch

You can extend a network or subscriber VLAN to another switch without configuring a PVLAN on that switch. This configuration is introduced in [“Extending Network and Subscriber VLANs to Other Switches” on page 543](#).

To add a network VLAN port as a PVLAN endpoint, use the following command:

```
configure {vlan} <vlan_name> add ports <port_list> tagged private-vlan end-point
```

To configure the port on the switch that is outside of the PVLAN, use the following command:

```
configure {vlan} <vlan_name> add ports <port_list> tagged
```

Adding a Loopback Port to a Subscriber VLAN

BlackDiamond 8000 series modules and Summit family switches, whether or not included in a SummitStack, require a loopback port for certain configurations. If two or more subscriber VLANs have overlapping ports (where the same ports are assigned to both VLANs), each of the subscriber VLANs with overlapping ports must have a dedicated loopback port.

The loopback port can be added when the subscriber VLAN is added to the PVLAN. If you need to add a loopback port to an existing subscriber VLAN, use the following command:

```
configure {vlan} <vlan_name> vlan-translation add loopback-port <port>
```

Managing Layer 3 Communications in a PVLAN

The default configuration for Layer 3 PVLAN communications is described in [“Layer 3 Communications” on page 545](#). To enable Layer 3 communications between all ports in a PVLAN, use the following command:

```
configure iparp add proxy [<ipNetmask> | <ip_addr> {<mask>}] {vr <vr_name>} {<mac> |
vrrp} {always}
```

Specify the IP address or subnet specified for the network VLAN in the PVLAN. Use the `always` option to ensure that the switch will reply to ARP requests, regardless of the VLAN from which it originated.

Deleting PVLANS

To delete an existing PVLAN, use the following command:

```
delete private-vlan <name>
```

Removing a VLAN from a PVLAN

When you remove a VLAN from a PVLAN, you remove the association between a VLAN and the PVLAN. Both the VLAN and PVLAN exist after the removal.

To remove a network or subscriber VLAN from a PVLAN, use the following command:

```
configure private-vlan <name> delete [network | subscriber] <vlan_name>
```

Deleting a Loopback Port from a Subscriber VLAN

To delete a loopback port from a subscriber VLAN, use the following command:

```
configure {vlan} <vlan_name> vlan-translation delete loopback-port
```

Displaying PVLAN Information

The following sections describe how to display PVLAN information:

- [Displaying Information for all PVLANS on page 550](#)
- [Displaying Information for a Specific PVLAN on page 550](#)
- [Displaying Information for a Network or Subscriber VLAN on page 550](#)

Displaying Information for all PVLANS

To display information on all the PVLANS configured on a switch, use the following command:

```
show private-vlan
```

Displaying Information for a Specific PVLAN

To display information about a single PVLANS, use the following command:

```
show {private-vlan} <name>
```

Displaying Information for a Network or Subscriber VLAN

To display information about a network or subscriber VLAN, use the following command:

```
show vlan {virtual-router} <vr-name>
```

The following flags provide PVLAN specific information:

- **s** flag—identifies a network VLAN port that the system added to a subscriber VLAN. All subscriber VLANs contain network VLAN ports that are marked with the **s** flag.
- **L** flag—identifies a subscriber VLAN port that is configured as a loopback port. Loopback ports are supported only on BlackDiamond 8000 series modules and Summit family switches, whether or not included in a SummitStack.

- **t flag**—identifies a tagged network VLAN port on which tag translation is enabled. The **t** flag only appears in the `show vlan` display for network VLANs.
- **e flag**—identifies a network VLAN port that is configured as an endpoint. The **e** flag only appears in the `show vlan` display for network VLANs.

Displaying PVLAN FDB Entries

To view all FDB entries including those created for a PVLAN, enter the following command:

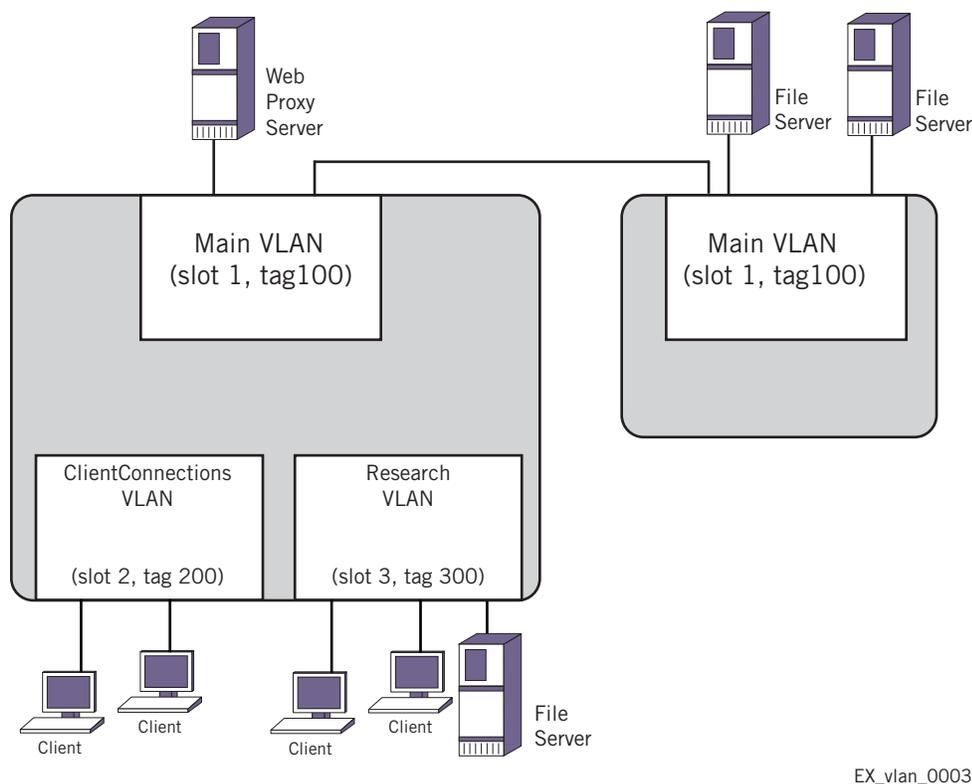
```
show fdb {blackhole {netlogin [all | mac-based-vlans]} | netlogin [all | mac-based-
vlans] | permanent {netlogin [all | mac-based-vlans]} | <mac_addr> {netlogin [all |
mac-based-vlans]} | ports <port_list> {netlogin [all | mac-based-vlans]} | vlan
<vlan_name> {netlogin [all | mac-based-vlans]} | {{vpls} {<vpls_name>}}
```

The **P** flag marks additional FDB entries for PVLANS.

PVLAN Configuration Example 1

Figure 64 shows a PVLAN configuration example for a medical research lab.

Figure 64: PVLAN Configuration Example 1



The medical research lab hosts lots of visiting clients. Each client has their own room, and the lab wants to grant them access to the internet through a local web proxy server but prevent them from accessing other visiting clients. There is a lab in the building where many research workstations are located. Workstations within the lab require access to other lab workstations, the internet, and file servers that are connected to a switch in another building. Visiting clients should not have access to the Research VLAN devices or the file servers on the remote switch.

The PVLAN in [Figure 64](#) contains the following PVLAN components:

- Network VLAN named Main, which provides internet access through the proxy web server and access to file servers on the remote switch.
- Isolated subscriber VLAN named ClientConnections, which provides internet access for visiting clients and isolation from other visiting clients, the Research VLAN devices, and the remote file servers.
- Non-isolated subscriber VLAN named Research, which provides internet access and enables communications between Research VLAN devices and the remote file servers.

The first configuration step is to create and configure the VLANs on the local switch:

```
create vlan Main
configure vlan Main add port 1:*
configure vlan Main tag 100
create vlan ClientConnections
configure vlan ClientConnections add port 2:*
configure vlan ClientConnections tag 200
create vlan Research
configure vlan Research add port 3:*
configure vlan Research tag 300
```

The remote switch VLAN is configured as follows:

```
create vlan Main
configure vlan Main add port 1:*
configure vlan Main tag 100
```

The next step is to create the PVLAN on the local switch and configure each of the component VLANs for the proper role:

```
create private-vlan MedPrivate
configure private-vlan "MedPrivate" add network "Main"
configure private-vlan "MedPrivate" add subscriber "ClientConnections"
configure private-vlan "MedPrivate" add subscriber "Research" non-isolated
```

The final step is to configure VLAN translation on the local switch so that Research VLAN workstations can connect to the file servers on the remote switch:

```
configure Main add ports 1:1 private-vlan translated
```

To view the completed configuration, enter the `show private-vlan` command as follows:

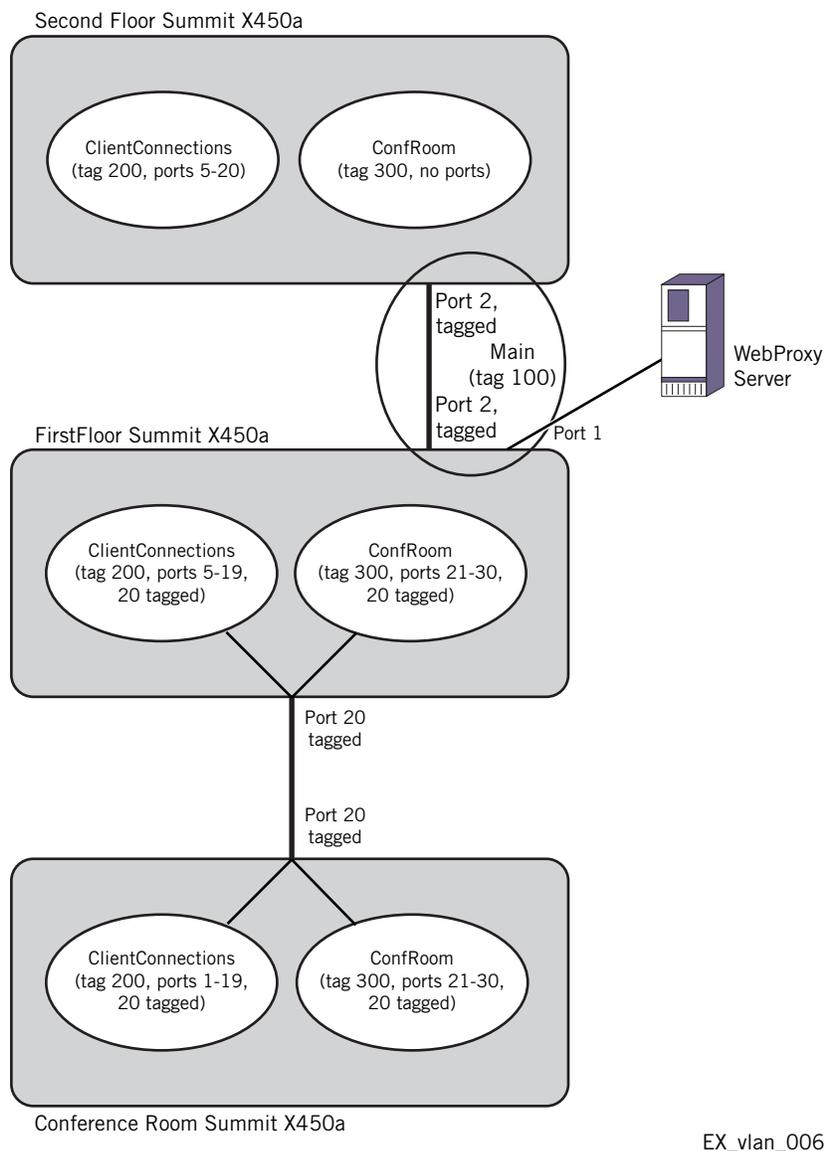
```
show private-vlan
-----
```

Name	VID	Protocol	Addr	Flags	Proto	Ports	Virtual
						Active	router
						/Total	
MedPrivate							VR-Default
Network VLAN:							
-main	100				ANY	2 /48	VR-Default
Non-Isolated Subscriber VLAN:							
-Research	300				ANY	2 /96	VR-Default
Isolated Subscriber VLAN:							
-ClientConnections	200				ANY	2 /52	VR-Default

PVLAN Configuration Example 2

Figure 65 shows a PVLAN configuration example for a motel.

Figure 65: PVLAN Configuration Example 2



The motel example in Figure 65 has guest rooms, a conference room, and their web proxy server on the first floor, and guest rooms on the second floor. The motel has three Summit X450a switches. There is one on the first floor in a closet, one on the first floor in the conference room, and one on the second floor.

The PVLAN in Figure 65 contains the following PVLAN components:

- A VLAN called Main that contains the web proxy server.
- A VLAN called ConfRoom that contains the ports for the conference room connections.
- A VLAN called ClientConnections that contains client PC connections for the guest rooms.

The goals for the motel network are as follows:

- Provide internet access for the ConfRoom and ClientConnections VLANs through the web proxy server.
- Prevent communications between the ConfRoom and ClientConnections VLANs
- Enable communications between clients on the ClientConnections VLAN only within the conference room.
- Enable communications between devices on the ConfRoom VLAN.
- Prevent communications between the PCs in the ClientConnections VLAN that are not in the conference room.

Notice the following in [Figure 65](#):

- The Summit X450a switches in the first floor closet and on the second floor contain the Main VLAN with a tag of 100. This VLAN is connected via a tagged port between the first and second floor switches.
- The Summit X450a in the conference room does not contain the Main VLAN and cannot be a PVLAN member.
- All of the switches have the ClientConnections VLAN, and it uses VLAN tag 200.
- All of the switches have the ConfRoom VLAN, and it uses VLAN tag 300.
- The Conference Room Summit X450a connects to the rest of the network through a tagged connection to the Summit X450a in the first floor closet.
- Because the Summit X450a in the first floor closet is a PVLAN member and uses the same port to support two subscriber VLANs, a loopback port is required in all subscriber VLANs, except the first configured subscriber VLAN (this applies to all BlackDiamond 8800 series switches and Summit family switches).

**NOTE**

The following examples contain comments that follow the CLI comment character (#). All text that follows this character is ignored by the switch and can be omitted from the switch configuration.

The following commands configure the Summit X450a in the first floor closet:

```
# Create and configure the VLANs.
create vlan Main
configure vlan Main add port 1
configure vlan Main tag 100
configure vlan Main add port 2 tagged
create vlan ClientConnections
configure vlan ClientConnections tag 200
configure vlan ClientConnections add port 5-19
configure vlan ClientConnections add port 20 tagged
create vlan ConfRoom
configure vlan ConfRoom tag 300
configure vlan ConfRoom add port 21-30
configure vlan ConfRoom add port 20 tagged
```

```
# Create and configure the PVLAN named Motel.
create private-vlan Motel
configure private-vlan Motel add network Main
configure private-vlan Motel add subscriber ClientConnections # isolated subscriber
VLAN
configure private-vlan "Motel" add subscriber "ConfRoom" non-isolated loopback-port 30
configure private-vlan Motel add subscriber ConfRoom non-isolated
# If you omit the loopback-port command, the above command produces the following
error message:
# Cannot add subscriber because another subscriber vlan is already present on the same
port, assign a loopback port when adding the subscriber vlan to the private vlan

show vlan "ConfRoom"
VLAN Interface with name ConfRoom created by user
  Admin State:      Enabled          Tagging:          802.1Q Tag 300
  Virtual router:  VR-Default
  IPv6:             None
  STPD:             None
  Protocol:         Match all unfiltered protocols
  Loopback:         Disabled
  NetLogin:         Disabled
  QosProfile:       None configured
  Egress Rate Limit Designated Port: None configured
  Private-VLAN Name:      Motel
  VLAN Type in Private-VLAN:  Non-Isolated Subscriber
  Ports:  13.          (Number of active ports=1)
    Untag:    21,    22,    23,    24,    25,    26,    27,
             28,    29
    Tag:      1s,    2s,    20,    *30L
  Flags:    (*) Active, (!) Disabled, (g) Load Sharing port
            (b) Port blocked on the vlan, (m) Mac-Based port
            (a) Egress traffic allowed for NetLogin
            (u) Egress traffic unallowed for NetLogin
            (t) Translate VLAN tag for Private-VLAN
            (s) Private-VLAN System Port, (L) Loopback port
            (e) Private-VLAN End Point Port
            (x) VMAN Tag Translated port
            (G) Multi-switch LAG Group port
```

Note that the loopback port is flagged with an "L" and listed as a tagged port, and the network VLAN ports are flagged with an "s" and listed as tagged ports.

The following commands configure the Summit X450a on the second floor:

```
# create and configure the VLANs
create vlan Main
configure vlan Main tag 100
configure vlan Main add port 2 tagged
create vlan ClientConnections
configure vlan ClientConnections tag 200
configure vlan ClientConnections add port 5-20
create vlan ConfRoom
configure vlan ConfRoom tag 300
```

```
# Create and configure the PVLAN named Motel.
create private-vlan Motel
configure private-vlan Motel add network Main
configure private-vlan Motel add subscriber ClientConnections # isolated subscriber
VLAN
configure private-vlan Motel add subscriber ConfRoom non-isolated
```

The following commands configure the Summit X450a in the conference room:

```
# create and configure the VLANs
create vlan ClientConnections
configure vlan ClientConnections tag 200
configure vlan ClientConnections add port 1-19
configure vlan ClientConnections add port 20 tag
create vlan ConfRoom
configure vlan ConfRoom tag 300
configure vlan ConfRoom add port 21-30
configure vlan ConfRoom add port 20 tag
```

```
# The VLANs operate as extensions of the VLANs on the Summit X450a in the first floor
closet. There is no PVLAN configuration on this switch.
```

VLAN Translation

The VLAN translation feature described in this section provides the same VLAN translation functionality that is provided for PVLANs and described in [“VLAN Translation in a PVLAN” on page 538](#). The difference is that this feature is configured with different commands that are compatible with ExtremeWare.



NOTE

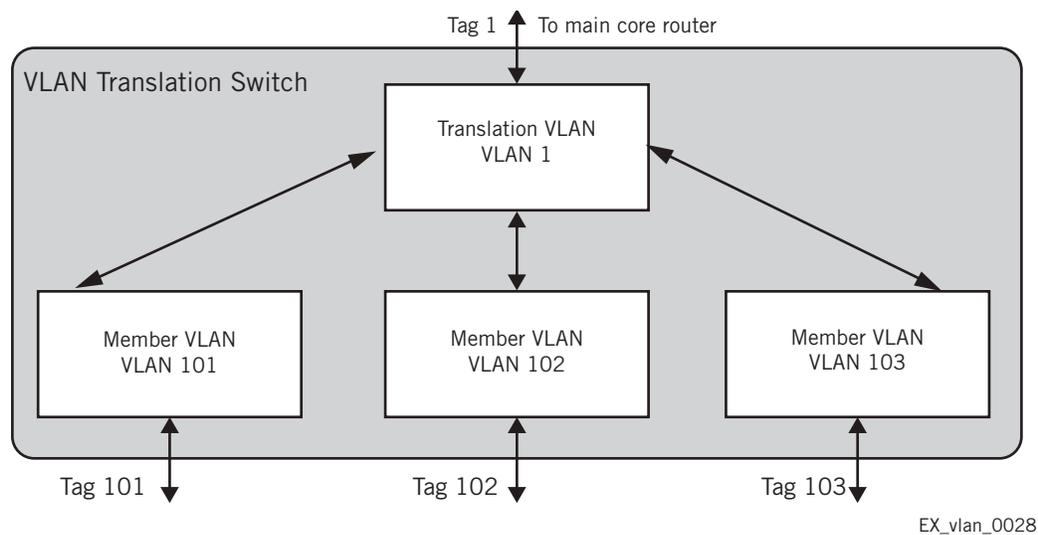
The VLAN translation feature described in this section is provided for those who are already familiar with the ExtremeWare VLAN translation commands. If you have not used this feature in ExtremeWare and do not use any scripts that use the ExtremeWare commands, we suggest that you use the Private VLAN feature described in [“Private VLANs” on page 538](#), as it provides the same functionality with additional features.



NOTE

The VLAN translation feature is supported only on the platforms listed for this feature in the license tables in [Appendix A, “Feature License Requirements.”](#)

[Figure 66](#) shows how VLAN translation is configured in the switch.

Figure 66: VLAN Translation Switch Configuration

In [Figure 66](#), VLAN1 is configured as a *translation VLAN*. The translation VLAN is equivalent to the *network VLAN* in the PVLAN implementation of VLAN translation.

VLANs 101, 102, and 103 are configured as *member VLANs* of translation VLAN1. The member VLANs are equivalent to the *non-isolated subscriber VLANs* in the PVLAN implementation of VLAN translation.

This configuration enables tag translation between the translation VLAN and the member VLANs. All member VLANs can communicate through the translation VLAN, but they cannot communicate through Layer 2 with each other.

The following sections provide information on VLAN translation:

- [VLAN Translation Behavior on page 557](#)
- [VLAN Translation Limitations on page 558](#)
- [Configuring Translation VLANs on page 559](#)
- [VLAN Translation Configuration Examples on page 560](#)

VLAN Translation Behavior

You should be aware of the behavior of unicast, broadcast, and multicast traffic when using VLAN translation.

Unicast Traffic

Traffic on the member VLANs can be either tagged or untagged. Traffic is switched locally between client devices on the same member VLAN as normal. Traffic cannot be switched between clients on separate member VLANs. Traffic from any member VLAN destined for the translation VLAN is switched and the VLAN tag is translated appropriately. Traffic from the translation VLAN destined for any member VLAN is switched and the VLAN tag is translated.

Broadcast Behavior

Broadcast traffic generated on a member VLAN is replicated in every other active port of that VLAN as normal. In addition, the member VLAN traffic is replicated to every active port in the translation VLAN and the VLAN tag is translated appropriately. Broadcast traffic generated on the translation VLAN is replicated to every other active port in this VLAN as usual. The caveat in this scenario is that this traffic is also replicated to every active port in every member VLAN, with VLAN tag translation. In effect, the broadcast traffic from the translation VLAN leaks onto all member VLANs.

Multicast Behavior

IGMP snooping can be enabled on member and translation VLANs so that multicast traffic can be monitored within the network. IGMP snooping software examines all IGMP control traffic that enters the switch. IGMP control traffic received on a VLAN translation port is forwarded by the CPU to all other ports in the translation group. Software VLAN translation is performed on the packets which cross the translation boundary between member and translation VLANs. The snooping software detects ports joining and leaving multicast streams. When a VLAN translation port joins a multicast group, an FDB entry is installed only on receiving a data miss for that group. The FDB entry is added for the requested multicast address and contains a multicast PTAG. When a VLAN translation port leaves a multicast group, the port is removed from the multicast list. The last VLAN translation port to leave a multicast group causes the multicast FDB entry to be removed.

VLAN Translation Limitations

The VLAN translation feature has the following limitations:

- Requires more FDB entries than a standard VLAN
- Within the same VR, VLAN tag duplication is not allowed
- Within the same VR, VLAN name duplication is not allowed
- Each MAC address learned in the translation and member VLANs must be unique. A MAC address cannot exist in two or more VLANs that belong to the same VLAN translation domain.
- MVR cannot be configured on translation and member VLANs.
- A VMAN cannot be added to translation and member VLANs.
- A PBB network (BVLAN) cannot be added to translation and member VLANs.
- EAPS control VLANs cannot be either translation or member VLANs.
- EAPS can only be configured on translation VLAN ports (and not on member VLAN ports). To support EAPS on the network VLAN, you must add all of the translation and member VLANs to the EAPS ring.
- STP can only be configured on translation VLAN ports (and not on member VLAN ports). To support STP on the translation VLAN, you must add the translation VLAN and all of the member VLANs to STP.
- ESRP can only be configured on translation VLAN ports (and not on member VLAN ports). To support ESRP on the network VLAN, you must add the translation VLAN and all of the member VLANs to ESRP.
- There is no NetLogin support to add ports as translate to the translation VLAN, but the rest of NetLogin and the PVLAN feature do not conflict.
- IGMP snooping is performed across the entire VLAN translation domain, spanning all the member VLANs. For VLANs that are not part of a VLAN translation domain, IGMP snooping operates as normal.

- VLAN translation and VPLS are not supported on the same VLAN.
- Member VLANs in a VLAN translation domain cannot exchange multicast data with VLANs outside the VLAN translation domain. However, the translation VLAN can exchange multicast data with VLANs outside the VLAN translation domain and with translation VLANs in other VLAN translation domains.

Interfaces

Use the following information for selecting and configuring VLAN translation interfaces:

- A single physical port can be added to multiple member VLANs, using different VLAN tags.
- Member VLANs and translation VLANs can include both tagged and untagged ports.

Configuring Translation VLANs

To create a translation VLAN, do the following:

- Create the VLAN that will become the translation VLAN
- Add a tag and ports to the prospective translation VLAN
- Add member VLANs to the prospective translation VLAN

A prospective translation VLAN becomes a translation VLAN when the first member VLAN is added to it. To add a member VLAN to a translation VLAN, use the following command:

```
configure {vlan} <vlan_name> vlan-translation add member-vlan <member_vlan_name>
{loopback-port <port>}
```

To delete a member VLAN from a translation VLAN, use the following command:

```
configure {vlan} <vlan_name> vlan-translation delete member-vlan [<member_vlan_name> |
all]
```

To view the translation VLAN participation status of a VLAN, use the following command:

```
show vlan {virtual-router <vr-name>}
```

Displaying Translation VLAN Information

The following sections describe how to display translation VLAN information:

- [Displaying Information for a Translation or Member VLAN on page 559](#)
- [Displaying Translation VLAN FDB Entries on page 560](#)

Displaying Information for a Translation or Member VLAN

To display information about a translation or member VLAN, use the following command:

```
show vlan {virtual-router <vr-name>}
```

Displaying Translation VLAN FDB Entries

To view all FDB entries including those created for a translation VLAN, enter the following command:

```
show fdb {blackhole {netlogin [all | mac-based-vlans]} | netlogin [all | mac-based-
vlans] | permanent {netlogin [all | mac-based-vlans]} | <mac_addr> {netlogin [all |
mac-based-vlans]} | ports <port_list> {netlogin [all | mac-based-vlans]} | vlan
<vlan_name> {netlogin [all | mac-based-vlans]} | {{vpls} {<vpls_name>}}}
```

The *T* flag marks additional FDB entries for translation VLANs.

VLAN Translation Configuration Examples

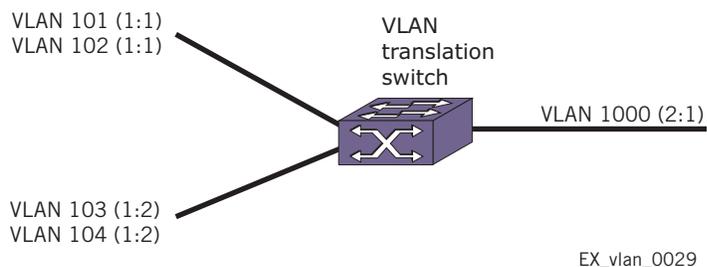
The following configuration examples show VLAN translation used in three scenarios:

- [Basic VLAN Translation on page 560](#)
- [VLAN Translation with ESRP Redundancy on page 561](#)
- [VLAN Translation with STP Redundancy on page 563](#)

Basic VLAN Translation

The example shown in [Figure 67](#) configures a basic VLAN translation network. This network provides VLAN translation between four member VLANs and a single translation VLAN.

Figure 67: VLAN Translation Configuration Example



The following configuration commands create the member VLANs:

```
create vlan v101
configure v101 tag 101
configure v101 add ports 1:1 tagged
create vlan v102
configure v102 tag 102
configure v102 add ports 1:1 tagged
create vlan v103
configure v103 tag 103
configure v103 add ports 1:2 tagged
create vlan v104
configure v104 tag 104
configure v104 add ports 1:2 tagged
```

The following configuration commands create the translation VLAN and enable VLAN translation:

```
create vlan v1000
configure v1000 tag 1000
configure v1000 add ports 2:1 tagged
configure v1000 vlan-translation add member-vlan v101
```

```

configure v1000 vlan-translation add member-vlan v102
configure v1000 vlan-translation add member-vlan v103
configure v1000 vlan-translation add member-vlan v104

```

The following configuration commands create the translation VLAN and enable VLAN translation on BlackDiamond X8, BlackDiamond 8000 series modules, and Summit X250e, X440, X450a, X450e, X460, X480, X650, and X670 series switches:

```

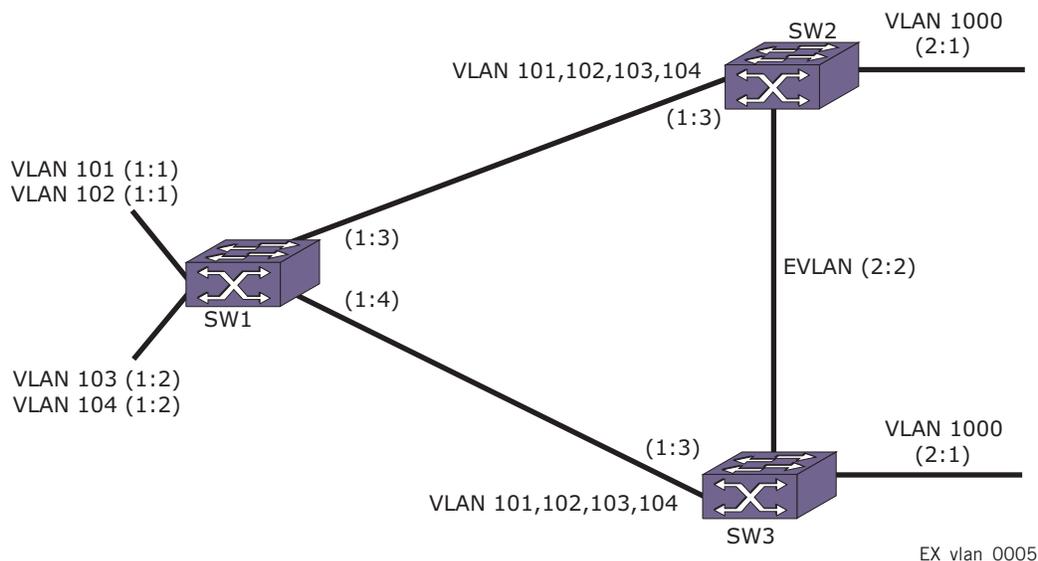
create vlan v1000
configure v1000 tag 1000
configure v1000 add ports 2:1 tagged
configure v1000 vlan-translation add member-vlan v101
configure v1000 vlan-translation add member-vlan v102 loopback-port 1:23
configure v1000 vlan-translation add member-vlan v103
configure v1000 vlan-translation add member-vlan v104 loopback-port 1:24

```

VLAN Translation with ESRP Redundancy

The example shown in [Figure 68](#) configures a VLAN translation network with ESRP redundancy. The SW2 and SW3 VLAN translation switches are protected by an ESRP control VLAN. The master ESRP switch performs the translation and provides the connectivity to the backbone. If a failure occurs, the slave ESRP switch takes over and begins performing the translation.

Figure 68: ESRP Redundancy Configuration Example



The following configuration commands create the member VLANs on SW1:

```

create vlan v101
configure v101 tag 101
configure v101 add ports 1:1 tagged
configure v101 add ports 1:3 tagged
configure v101 add ports 1:4 tagged
create vlan v102
configure v102 tag 102
configure v102 add ports 1:1 tagged
configure v102 add ports 1:3 tagged
configure v102 add ports 1:4 tagged

```

```
create vlan v103
configure v103 tag 103
configure v103 add ports 1:2 tagged
configure v103 add ports 1:3 tagged
configure v103 add ports 1:4 tagged
create vlan v104
configure v104 tag 104
configure v104 add ports 1:2 tagged
configure v104 add ports 1:3 tagged
configure v104 add ports 1:4 tagged
```

The configuration for SW2 and SW3 is identical for this example. The following configuration commands create the member VLANs on SW2:

```
create vlan v101
configure v101 tag 101
configure v101 add ports 1:3 tagged
create vlan v102
configure v102 tag 102
configure v102 add ports 1:3 tagged
create vlan v103
configure v103 tag 103
configure v103 add ports 1:3 tagged
create vlan v104
configure v104 tag 104
configure v104 add ports 1:3 tagged
```

This set of configuration commands creates the translation VLANs and enables VLAN translation on SW2:

```
create vlan v1000
configure v1000 tag 1000
configure v1000 add ports 2:1 tagged
configure v1000 vlan-translation add member-vlan v101
configure v1000 vlan-translation add member-vlan v102
configure v1000 vlan-translation add member-vlan v103
configure v1000 vlan-translation add member-vlan v104
```

The final set of configuration commands creates the ESRP control VLAN and enables ESRP protection on the translation VLAN for SW2:

```
create vlan evlan
configure evlan add ports 2:2
enable esrp evlan
configure evlan add domain-member v1000
```

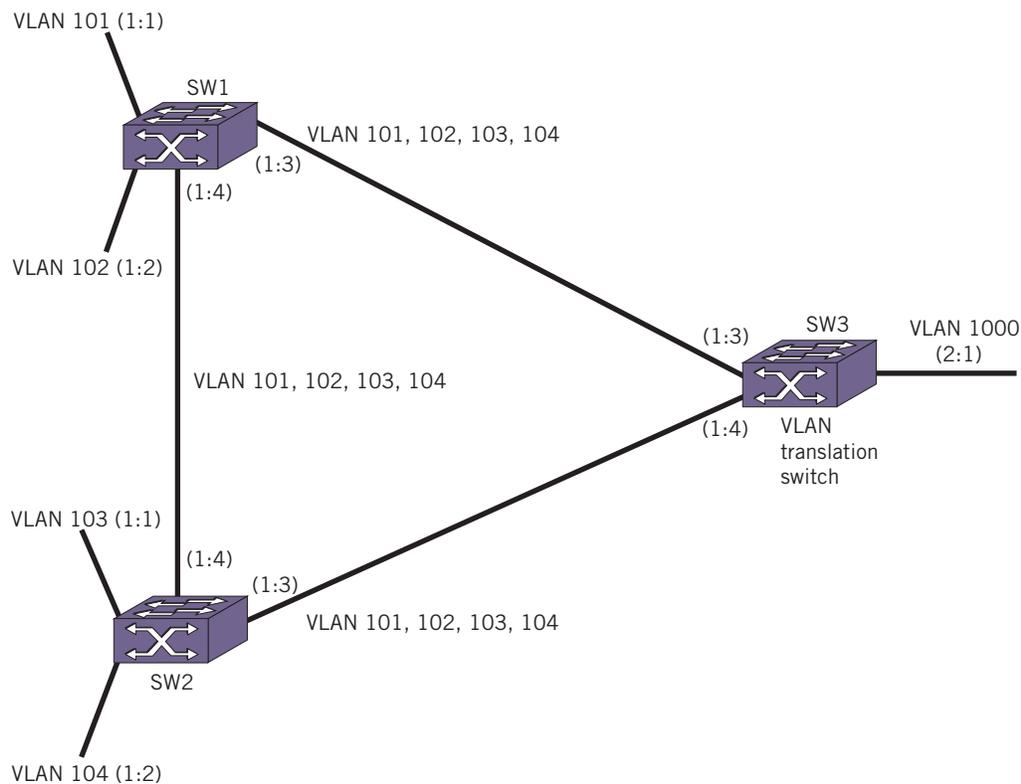
The following configuration commands create the translation VLAN and enable VLAN translation on BlackDiamond 8000 series modules and Summit X250e, X440, X450a, X450e, X460, X480, X650, and X670 series switches:

```
create vlan v1000
configure v1000 tag 1000
configure v1000 add ports 2:1 tagged
configure v1000 vlan-translation add member-vlan v101
configure v1000 vlan-translation add member-vlan v102 loopback-port 1:22
configure v1000 vlan-translation add member-vlan v103 loopback-port 1:23
configure v1000 vlan-translation add member-vlan v104 loopback-port 1:24
```

VLAN Translation with STP Redundancy

The example shown in [Figure 69](#) configures a VLAN translation network with redundant paths protected by STP. Parallel paths exist from the member VLAN portion of the network to the translation switch. STP ensures that the main path for this traffic is active and the secondary path is blocked. If a failure occurs in the main path, the secondary paths are enabled.

Figure 69: STP Redundancy Configuration Example



EX_vlan_0026

The following configuration commands create the member VLANs and enable STP on SW1:

```
create vlan v101
configure v101 tag 101
configure v101 add ports 1:1 tagged
configure v101 add ports 1:3 tagged
configure v101 add ports 1:4 tagged
create vlan v102
configure v102 tag 102
configure v102 add ports 1:2 tagged
configure v102 add ports 1:3 tagged
configure v102 add ports 1:4 tagged
create vlan v103
configure v103 tag 103
configure v103 add ports 1:3 tagged
configure v103 add ports 1:4 tagged
create vlan v104
configure v104 tag 104
configure v104 add ports 1:3 tagged
configure v104 add ports 1:4 tagged
create stpd stp1
```

```
configure stp1 tag 101
configure stp1 add vlan v101
configure stp1 add vlan v102
configure stp1 add vlan v103
configure stp1 add vlan v104
enable stpd stp1
```

These configuration commands create the member VLANs and enable STP on SW2:

```
create vlan v103
configure v103 tag 103
configure v103 add ports 1:1 tagged
configure v103 add ports 1:3 tagged
configure v103 add ports 1:4 tagged
create vlan v104
configure v104 tag 104
configure v104 add ports 1:2 tagged
configure v104 add ports 1:3 tagged
configure v104 add ports 1:4 tagged
create vlan v101
configure v101 tag 101
configure v101 add ports 1:3 tagged
configure v101 add ports 1:4 tagged
create vlan v102
configure v102 tag 102
configure v102 add ports 1:3 tagged
configure v102 add ports 1:4 tagged
create stpd stp1
configure stp1 tag 101
configure stp1 add vlan v101
configure stp1 add vlan v102
configure stp1 add vlan v103
configure stp1 add vlan v104
enable stpd stp1
```

This set of configuration commands creates the member VLANs and enables STP on SW3:

```
create vlan v101
configure v101 tag 101
configure v101 add ports 1:3 tagged
configure v101 add ports 1:4 tagged
create vlan v102
configure v102 tag 102
configure v102 add ports 1:3 tagged
configure v102 add ports 1:4 tagged
create vlan v103
configure v103 tag 103
configure v103 add ports 1:3 tagged
configure v103 add ports 1:4 tagged
create vlan v104
configure v104 tag 104
configure v104 add ports 1:3 tagged
configure v104 add ports 1:4 tagged
create stpd stp1
```

```
configure stp1 tag 101
configure stp1 add vlan v101
configure stp1 add vlan v102
configure stp1 add vlan v103
configure stp1 add vlan v104
enable stpd stp1
```

The final set of configuration commands creates the translation VLAN and enables VLAN translation on SW3:

```
create vlan v1000
configure v1000 tag 1000
configure v1000 add ports 2:1 tagged
configure v1000 vlan-translation add member-vlan v101
configure v1000 vlan-translation add member-vlan v102
configure v1000 vlan-translation add member-vlan v103
configure v1000 vlan-translation add member-vlan v104
```

The following configuration commands create the translation VLAN and enable VLAN translation on BlackDiamond 8000 series modules and Summit X250e, X440, X450a, X450e, X460, X480, X650, and X670 series switches:

```
create vlan v1000
configure v1000 tag 1000
configure v1000 add ports 2:1 tagged
configure v1000 vlan-translation add member-vlan v101
configure v1000 vlan-translation add member-vlan v102 loopback-port 1:22
configure v1000 vlan-translation add member-vlan v103 loopback-port 1:23
configure v1000 vlan-translation add member-vlan v104 loopback-port 1:24
```


13

CHAPTER

VMAN (PBN) and PBBN

This chapter includes the following sections:

- [Overview on page 567](#)
- [Configuration on page 578](#)
- [Displaying Information on page 582](#)
- [Configuration Examples on page 583](#)

Overview

The virtual metropolitan area network (VMAN) and Provider Backbone Bridged Network (PBBN) features allow you to scale a Layer 2 network and avoid some of the management and bandwidth overhead required by Layer 3 networks.

The following sections provide more information on these features:

- [VMANs on page 567](#)
- [PBBNs on page 572](#)
- [VMAN Configuration Options and Features on page 575](#)



NOTE

If a failover from MSM A to MSM B occurs, VMAN operation is not interrupted. The system has hitless failover—network traffic is not interrupted during a failover.

VMANs

The VMAN feature is defined by the IEEE 802.1ad standard, which is an amendment to the IEEE 802.1Q VLAN standard. A VMAN is a virtual Metropolitan Area Network (MAN) that operates over a physical MAN or Provider Bridged Network (PBN). This feature allows a service provider to create VMAN instances within a MAN or PBN to support individual customers. Each VMAN supports tagged and untagged VLAN traffic for a customer, and this traffic is kept private from other customers that use VMANs on the same PBN.

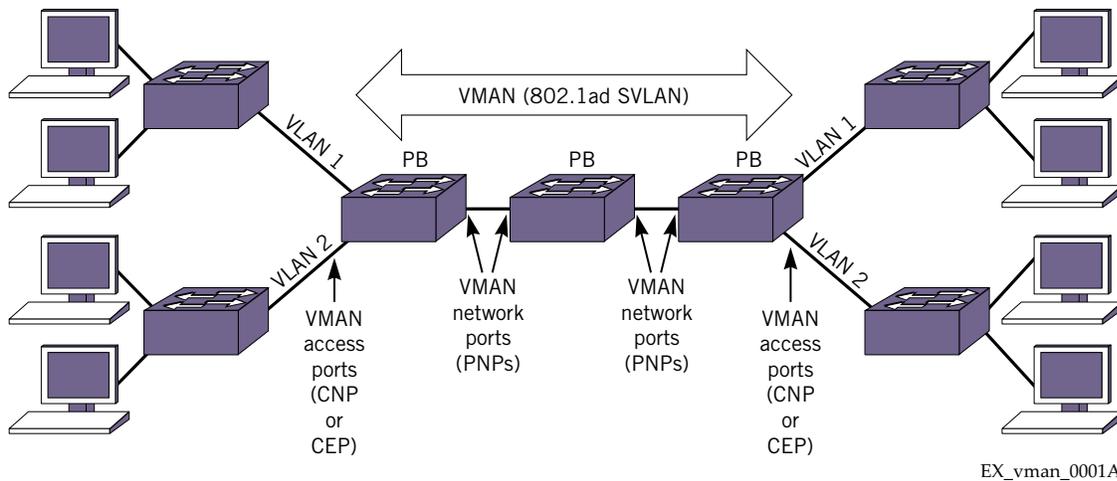
The PBN uses Provider Bridges (PBs) to create a Layer 2 network that supports VMAN traffic. The VMAN technology is sometimes referred to as VLAN *stacking* or *Q-in-Q*.

**NOTE**

VMAN is an Extreme Networks term that became familiar to Extreme Networks customers before the 802.1ad standard was complete. The VMAN term is used in the ExtremeXOS software and also in this book to support customers who are familiar with this term. The PBN term is also used in this guide to establish the relationship between this industry standard technology and the Extreme Networks VMAN feature.

Figure 70 shows a VMAN, which spans the switches in a PBN.

Figure 70: VMAN



The entry points to the VMAN are the access ports on the VMAN edge switches. Customer VLAN (CVLAN) traffic that is addressed to locations at other VMAN access ports enters the ingress access port, is switched through the VMAN, and exits the egress access port. If you do not configure any frame manipulation options, the CVLAN frames that exit the VMAN are identical to the frames that entered the VMAN.

VMAN access ports operate in the following roles:

- Customer Network Port (CNP)
- Customer Edge Port (CEP—which is also known as *Selective Q-in-Q*)

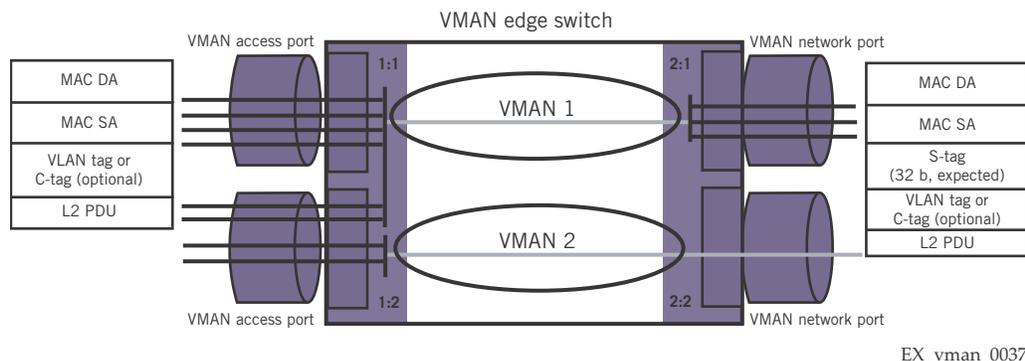
The CEP role, which is configured in software as a *cep vman port*, connects a VMAN to specific CVLANs based on the CVLAN CVID. The CNP role, which is configured as an *untagged vman port*, connects a VMAN to all other port traffic that is not already mapped to the port CEP role. These roles are described later in this chapter.

All other VMAN ports (except the access ports) operate as *vman network ports*, which are also known as *Provider Network Ports (PNPs)* in the 802.1ad standard. The VMAN network ports connect the PBs that form the core of the VMAN. During configuration, the VMAN network ports are configured as *tagged vman ports*.

Figure 70 shows one VMAN, but a PBN can support multiple VMAN instances, which are sometimes called VMANs or *Service VLANs (SVLANs)*. VMANs allow you to partition the PBN for customers in the same way that VLANs allow you to partition a Layer 2 network. For example, you can use different VMANs to support different customers on the PBN, and the PBN delivers customer traffic only to the PBN ports that are configured for appropriate VMAN.

A VMAN supports two tags in each Ethernet frame, instead of the single tag supported by a VLAN Ethernet frame. The inner tag is referred to as the *customer tag* (C-tag), and this optional tag is based on the CVLAN tag if the source VLAN is a tagged VLAN. The outer tag is referred to as the *service tag* (S-tag) or *VMAN tag* or *SVLAN tag*, and it is the tag that defines to which SVLAN a frame belongs. Figure 71 shows the frame manipulation that occurs at the VMAN edge switch.

Figure 71: Tag Usage at the VMAN Access Switch

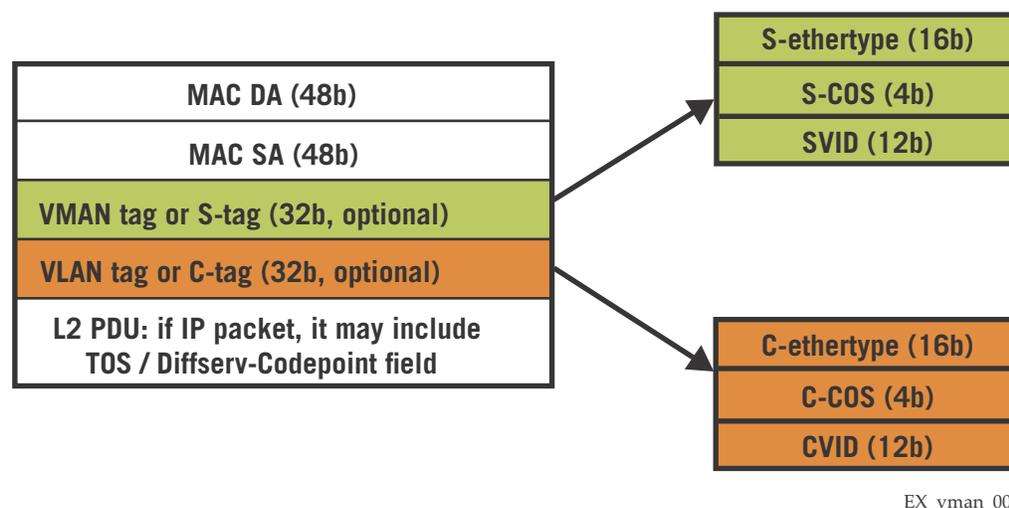


In Figure 71, the switch accepts CVLAN frames on VMAN access ports 1:1 and 1:2. The switch then adds the S-tag to the frames and switches the frames to network ports 2:1 and 2:2. When the 802.1ad frames reach the PB egress port, the egress switch removes the S-tag, and the CVLAN traffic exits the egress access port in its original form.

When the switch in Figure 71 acts as the egress switch for a VMAN, VMAN frames arrive on network ports 2:1 and 2:2. The switch accepts only those frames with the correct S-tag, removes the S-tags, and switches those frames to access ports 1:1 and 1:2. Unless special configuration options are applied, the egress frames are identical to ingress CVLAN frames. (Configuration options are described in “VMAN Configuration Options and Features” on page 575.)

Figure 72 shows that the S-tags and C-tags used in VMAN frames contain more than just customer and service VLAN IDs.

Figure 72: S-tag and C-tag Components



Each S-tag and C-tag contains an ethertype, a Class of Service (COS), and a SVLAN ID (SVID) or CVLAN ID (CVID). The ethertype is described in “Secondary Ethertype Support” on page 576, and the

COS is described in “QoS Support” on page 577. The SVID is the VLAN tag you assign to a VMAN when you create it (`configure vman <vman-name> tag <tag>`). The CVID represents the CVLAN tag for tagged VLAN traffic.

Switch ports support VMAN roles and features, which are described in the following sections:

- [Customer Network Ports on page 570](#)
- [Customer Edge Ports on page 570](#)
- [CVID Translation on page 571](#)
- [CVID Egress Filtering on page 571](#)

Customer Network Ports

Customer Network Ports (CNPs) are edge switch ports that accept all tagged and untagged CVLAN traffic and route it over a single VMAN. A CNP is simpler to configure than a CEP, because it supports one VMAN on a physical port and requires no configuration of CVIDs. The VMAN service provider does not need to know anything about the CVLAN traffic in the VMAN. The service provider simply manages the VMAN, and the ingress CVLAN traffic is managed by the customer or another service provider. This separation of CVLAN and VMAN management reduces the dependence of the separate management teams on each other, and allows both management teams to make changes independent of the other.



NOTE

The CNP term is defined in the IEEE 802.1ad standard and is also called a *port-based service interface*. The CNP operation is similar to a MEF 13 UNI Type 1.2, and in releases before ExtremeXOS 12.6, CNPs were known as *VMAN access ports* or *untagged vman ports*. With the addition of CEPs, the term *VMAN access port* is now a generic term that refers to CNPs and CEPs.

A PBN can support up to 4094 VMANs, and each VMAN can support up to 4094 CVLANs. Because each CNP connects to only one VMAN, the maximum number of customer VMANs on an edge switch is equal to the total number of switch ports minus 1, because at least one port is required to serve as the PNP.

Customer Edge Ports

Each CEP supports the configuration of connections or mappings between individual CVLANs and multiple VMANs. This provides the following benefits:

- Each physical port supports multiple customers (each connecting to a separate VMAN).
- Each switch supports many more customer VMANs using CEPs instead of CNPs.

To define the connections between CVLANs and SVLANs, each CEP uses a dedicated CVID map, which defines the supported CVIDs on the CEP and the destination VMAN for each CVID. For example, you can configure a CEP to forward traffic from 5 specific CVLANs to VMAN A and from 10 other specific CVLANs to VMAN B. During VMAN configuration, certain ports are added to the VMAN as CEPs, and certain CVIDs on those ports are mapped to the VMAN. To enable customer use of a VMAN, the service provider must communicate the enabled CVIDs to the customer, who must use those CVIDs to access the VMAN.

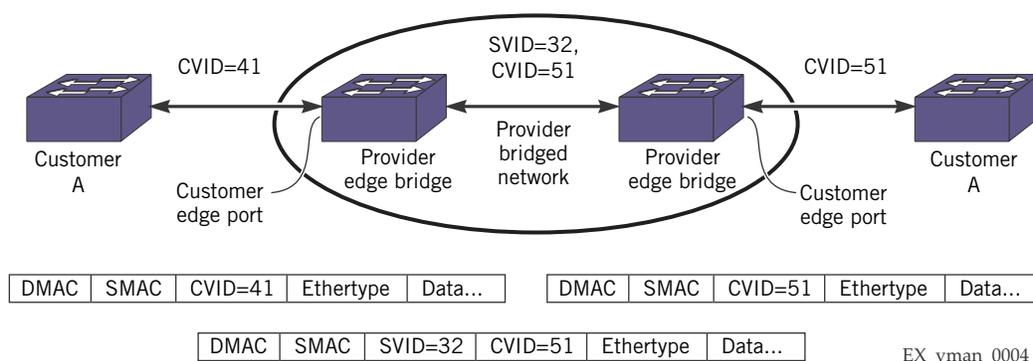
**NOTE**

The CEP term is defined in the IEEE 802.1ad standard and is also called a *C-tagged service interface*. The CEP operation is similar to a MEF 13 UNI Type 1.1.

CVID Translation

To support CVLANs that are identified by different CVIDs on different CEPs, some switches support a feature called CVID translation, which translates the CVID received at the VMAN ingress to a different CVID for egress from the VMAN (see [Figure 73](#)).

Figure 73: CVID Translation



You can use a CLI command to configure CVID translation for a single CVID or for a range of CVIDs, and you can enter multiple commands to define multiple CVIDs and ranges for translation. The CLI commands can be applied to a single port or a list of ports, and after configuration, the configuration applied to a port is retained by that port.

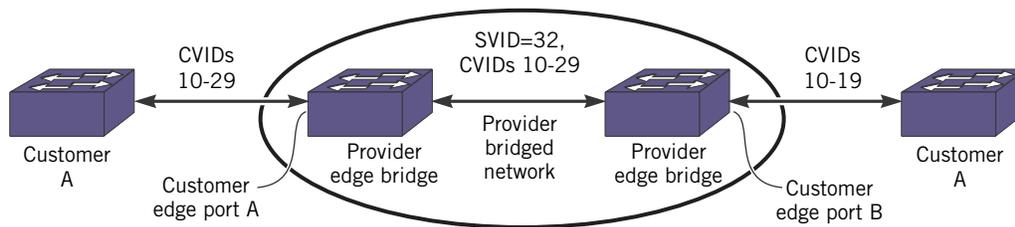
**NOTE**

CVID translation is available only on the platforms listed for this feature in [Appendix A, "Feature License Requirements."](#)

CVID translation can reduce the number of CVIDs that can be mapped to VMANs.

CVID Egress Filtering

CVID egress filtering permits the egress from VMAN to CEP of only those frames that contain a CVID that has been mapped to the source VMAN; all other frames are blocked. For example, Customer Edge Port A in [Figure 74](#) is configured to support CVIDs 10-29, and Customer Edge Port B is configured to support CVIDs 10-19. If CVID egress filtering is enabled on Customer Edge Port B, frames with CVIDs 20-29 will not be forwarded at the egress of Customer Edge Port B.

Figure 74: CVID Egress Filtering

EX_vman_0005

You can enable CVID egress filtering for a single CEP or for all CEPs with a CLI command. You can also repeat the command to enable this feature on multiple CEPs.

**NOTE**

CVID egress filtering is available only on the platforms listed for this feature in [Appendix A, "Feature License Requirements."](#)

When this feature is enabled, it reduces the maximum number of CVIDs that can be mapped to VMANs. The control of CVID egress filtering applies to fast-path forwarding. When frames are forwarded through software, CVID egress filtering is always enabled.

PBBNs

**NOTE**

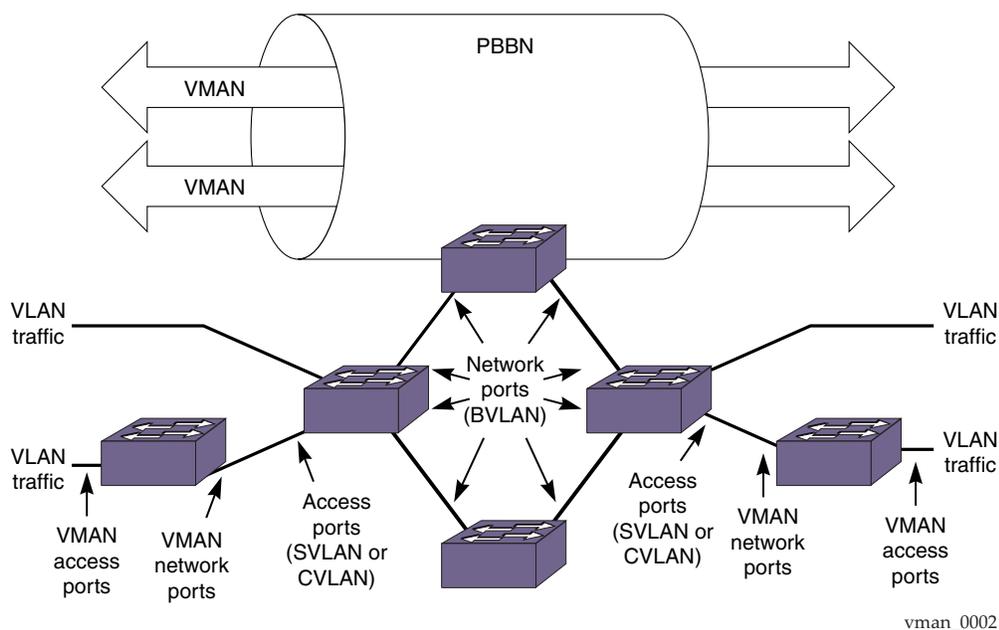
This feature is supported only on the platforms listed for this feature in the license and feature pack tables in [Appendix A, "Feature License Requirements."](#)

A Provider Backbone Bridge Network (PBBN) enables VMAN (PBN, 802.1ad frames) and customer VLAN (802.1Q frames) transport over a backbone network such as the internet. One application of a PBBN allows an Internet Service Provider (ISP) to create a backbone network over the internet to support Layer 2 traffic from service providers (SPs). Each service provider buys a PBN (VMAN) from the ISP and sells VLAN access to customers. The ISP configures the PBBN, each SP configures their PBN, and each customer configures their VLAN. The PBBN, PBNs, and VLANs are all isolated. All parties (ISP, SP, and customer) can establish their networks and services with minimal support from the other parties, and all parties can make most configuration changes independently of the others.

PBBNs are defined by the IEEE 802.1ah Backbone Bridge standard, which is an amendment to the IEEE 802.1Q VLAN standard. The PBBN technology is sometimes referred to as MAC-in-MAC.

[Figure 75](#) shows a PBBN, which spans a set of ISP switches that serve as Provider Backbone Bridges (PBBs).

Figure 75: PBBN



You can view a PBBN as a Layer 2 network that supports VMAN traffic (PBBN 802.1ad frames) and VLAN traffic (802.1Q frames). The entry points to a PBBN are the access ports on the PBBN edge switches, which function as *Backbone Edge Bridges* (BEBs). These ports are designed to receive and transmit VMAN and Customer VLAN (CVLAN) traffic.

PBBN switches that are not configured with network access ports are called *Backbone Core Bridges* (BCBs). BCBs are configured only with network ports and interconnect all the BEBs in the PBBN.

PBBN traffic enters a PBBN access port, is switched through the PBBN, and exits at a PBBN access port. If you do not configure any frame manipulation options, the frames that exit the PBBN are identical to the frames that entered the PBBN.

Figure 75 shows three terms that are used during the configuration of a PBBN: *CVLAN*, *SVLAN*, and *BVLAN*. A PBBN is a virtual tunnel. Service VLANs (SVLANs) and CVLANs are defined at the tunnel end points and define what traffic can enter and exit the tunnel. A BVLAN defines all the switch ports that link the tunnel endpoints. SVLANs, CVLANs, and BVLANs are configuration entities; they are not actual Layer 2 domains. These configuration entities define the roles of ports within the PBBN. These configuration entities operate as follows:

- When a CVLAN is configured on a port, the port accepts customer VLAN traffic (802.1Q frames) for the PBBN. After configuration is complete, the customer VLAN domain extends to all BEBs that have ports configured for the CVLAN. CVLANs are configured only on BlackDiamond 20800 series switches.
- When an SVLAN is configured on a port, the port accepts VMAN traffic (PBBN 802.1ad frames) for the PBBN. After configuration is complete, the VMAN domain extends to all BEBs that have ports configured for the SVLAN.
- When a backbone VLAN (BVLAN) is configured on a port, the port serves as a network port in the PBBN core. A BVLAN port forwards PBBN traffic (802.1ah frames) between the BEBs and BCBs in the PBBN.

When you configure a PBBN, you create and configure SVLANs and CVLANs on the PBBN access ports, and you configure a BVLAN on each network port. Later in the configuration process, you bind

each SVLAN and CVLAN to a BVLAN to establish the connection between the PBBN access ports and network ports that establish the BVLAN. The process for binding an SVLAN or CVLAN to a BVLAN differs between platforms.

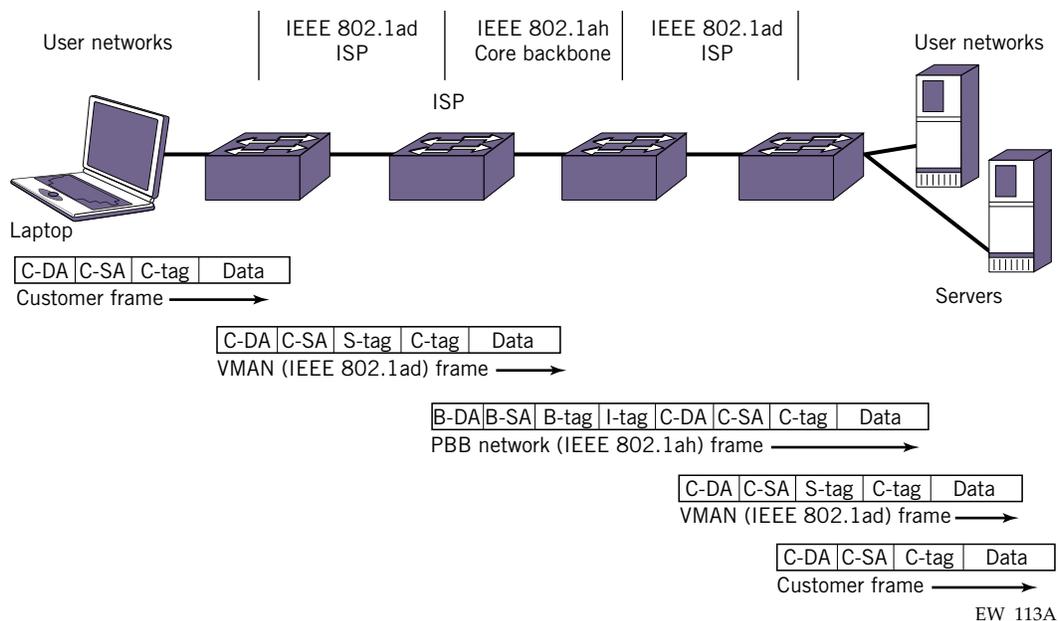
You can use any physical topology on the BVLAN. Although you can assign IP addresses to backbone interfaces to test connectivity, do not enable IP forwarding. The BVLAN must be tagged, and only tagged ports can be added to the BVLAN.

**NOTE**

After you configure a port as part of a BVLAN or SVLAN, you cannot apply any other ACLs to that port.

To switch a frame through the PBBN, the switch encapsulates VLAN and VMAN frames in 802.1ah frames as shown in [Figure 76](#).

Figure 76: Frame Manipulation Through a PBBN

**NOTE**

When you configure PBBNs on BlackDiamond 20800 series switches, egress mirroring on a BVLAN port is not supported for PBBN traffic that entered the PBBN through that node. In other words, the switch does not mirror packets leaving a BVLAN port if the packets entered the switch through a CVLAN or SVLAN port.

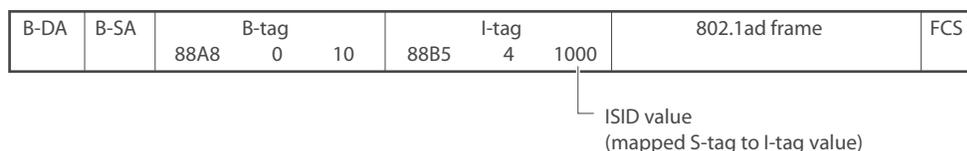
At the egress port of the PBBN, the system strips off the 802.1ah material, which leaves a VMAN frame containing an original customer frame with the service provider S-tag. At the end-point of the VMAN, the system strips off the 802.1ad material, which delivers the original customer VLAN frame to the designated destination.

**NOTE**

There is no interaction between the STPs of the ISP and the subscriber. The subscriber's BPDUs are tunneled through the PBBN on the ISP backbone.

Figure 77 shows the contents of an 802.1ah PBBN frame.

Figure 77: 802.1ah PBBN Frame Details



EW_115C

The PBBN-specific frame components are prepended to the 802.1ad VMAN frames and described in the following sections:

- [B-tag on page 575](#)
- [B-DA and B-SA on page 575](#)
- [I-tag on page 575](#)

B-tag. The BVLAN tag (B-tag) identifies a specific BVLAN and includes three priority bits for QoS.

B-DA and B-SA. The BVLAN destination MAC address (B-DA) and BVLAN source MAC address (B-SA) are used to switch frames across the PBBN.

I-tag. The I-tag identifies the service provider in the scope of PBBNs (the BVLAN is the tunnel inside of which the system uses the I-tag to identify the service provider using the I-tag to S-tag mapping and replacement).

The additional information in the I-tag allows the PBBN to support many more VMANs than the 4094 supported by the S-tag alone. SVLANs with duplicate S-tags are supported in a PBBN when they are received on different access ports, as this results in a different I-tag for each VMAN.

**NOTE**

For more information on the ethertype, see [“Secondary Ethertype Support” on page 576](#).

VMAN Configuration Options and Features

This section describes the following VMAN (PBN) configuration options and features:

- [ACL Support on page 576](#)
- [Secondary Ethertype Support on page 576](#)
- [QoS Support on page 577](#)
- [Egress Queue Selection on page 577](#)
- [Primary and Backup LAG Port Selection on page 577](#)

ACL Support

The ExtremeXOS software includes VMAN (PBN) Access Control List (ACL) support for controlling VMAN frames. VMAN ACLs define a set of match conditions and modifiers that can be applied to VMAN frames. These conditions allow specific traffic flows to be identified, and the modifiers allow a translation to be performed on the frames.

Secondary Ethertype Support



NOTE

This feature is supported only on the platforms listed for this feature in the license tables in [Appendix A, “Feature License Requirements.”](#)

The C-tag and S-tag components that are added to all VMAN (PBN) frames (see [Figure 72](#)) include C-ethertype and S-ethertype components that specify an ethertype value for the customer VLAN and VMAN, respectively. The I-tag used in PBBN frames (see [Figure 77](#)) also includes an ethertype value. When a VLAN or VMAN frame passes between two switches, the ethertype is checked for a match. If the ethertype does not match that of the receiving switch, the frame is discarded.

The default ethertype values are:

- VLAN port (802.1q frames): 0x8100
- Primary VMAN port (802.1ad frames): 0x88A8
- Secondary VMAN port (802.1ad frames): Not configured

The secondary ethertype support feature applies only to VMANs. The ethertype value for VLAN frames is standard and cannot be changed.

If your VMAN transits a third-party device (in other words, a device other than an Extreme Networks device), you must configure the ethertype value on the Extreme Networks device port to match the ethertype value on the third-party device to which it connects.

The secondary ethertype support feature allows you to define two ethertype values for VMAN frames and select either of the two values for each port. For example, you can configure ports that connect to other Extreme Networks devices to use the default primary ethertype value, and you can configure ports that connect to other equipment to use the secondary ethertype value, which you can configure to match the requirements of that equipment.

When you create a VMAN, each VMAN port is automatically assigned the primary ethertype value. After you define a secondary ethertype value, you can configure a port to use the secondary ethertype value. If two switch ports in the same VMAN use different ethertype values, the switch substitutes the correct value at each port. For example, for VMAN edge switches and transit switches, the switch translates an ingress ethertype value to the network port ethertype value before forwarding. For egress traffic at VMAN edge switches, no translation is required because the switch removes the S-tag before switching packets to the egress port.

For BlackDiamond 8800 series switches, SummitStack, and the Summit family of switches, you can set the primary and secondary ethertypes to any value, provided that the two values are different.

QoS Support

The VMAN (PBN) feature interoperates with many of the QoS and HQoS features supported in the ExtremeXOS software. One of those features is egress queue selection, which is described in the next section. For more information on other QoS and HQoS features that work with VMANs, see [Chapter 20, “QoS.”](#)

Egress Queue Selection



NOTE

This feature is supported only on the platforms listed for this feature in the license tables in [Appendix A, “Feature License Requirements.”](#)

This feature examines the 802.1p value or Diffserv code point in a VMAN (PBN) S-tag and uses that value to direct the packet to the appropriate queue on the egress port. On some systems (listed in [Appendix A, “Feature License Requirements”](#)), you can configure this feature to examine the values in the C-tag or the S-tag. For instructions on configuring this feature, see [“Selecting the Tag used for Egress Queue Selection”](#) on page 582.

Primary and Backup LAG Port Selection



NOTE

This feature is supported only on the platforms listed for this feature in the license tables in [Appendix A, “Feature License Requirements.”](#)

This feature allows LAG filtering using VMAN egress ACLs.

Customers normally do not have control over which load-sharing port traffic is sent. This feature allows you to select a port for a specific traffic stream. This is achieved by using a VMAN egress ACL with the LAG port specifications in it.

LAG filtering allows you to pick a specific port in the trunk group as your primary port and also specify another port as a backup port in case of failure of the primary port. You also have the option to have no backup port, use the entire LAG group, or use its internal logic to find the backup port. The port selection behavior holds true for flooded traffic even when the flooded ports are trunk or link aggregation groups. You can constrain the list of possible ports in the trunk group for each service selection.



NOTE

To support LAG filtering, the trunk group must be configured with the `algorithm address-based` option when the group is created with the `enable sharing grouping` command.

A typical LAG egress policy looks as follows. With this rule, any outgoing packet with an S-tag containing an SVID of 30 and going out of the load sharing group of ports 1:6 and 1:7, uses link 1:6. If link 1:6 is down the packet uses link 1:7.

```
entry policy_egress {
    if match all {
        svid 30;
    } then {
        link 1:6;
        back-up-link 1:7;
        count counter-1;
    }
}
```

An important condition to observe is that in the *if* clause, only SVID can be used for the VMAN LAG feature.

Configuration

The following sections describe how to configure VMANs and PBBNs:

- [Configuring VMANs \(PBNs\) on page 578](#)
- [Configuring VMAN Options on page 580](#)
- [Configuring VMAN Options on page 580](#)

Configuring VMANs (PBNs)

The following sections provide information on configuring VMANs:

- [Guidelines for Configuring VMANs on page 578](#)
- [Procedure for Configuring VMANs on page 579](#)

Guidelines for Configuring VMANs

The following sections provide VMAN configuration guidelines for the supported platforms:

- [Guidelines for All Platforms on page 578](#)
- [Guidelines for BlackDiamond X8 and 8000 Series Modules and Summit Family Switches on page 579](#)
- [If you already configured VLANs and VMANs on the same module or stand-alone switch using ExtremeXOS 11.4, you cannot change the VMAN ethertype from 0X8100 without first removing either the VLAN or VMAN configuration. on page 579](#)

Guidelines for All Platforms. The following are VMAN configuration guidelines for all platforms:

- Duplicate customer MAC addresses that ingress from multiple VMAN access ports on the same VMAN can disrupt the port learning association process in the switch.
- VMAN names must conform to the guidelines described in “Object Names” on page 42.
- You must use mutually exclusive names for:
 - VLANs
 - VMANs

- IPv6 tunnels
- CVLANs in PBBNs
- SVLANs in PBBNs
- BVLANs in PBBNs
- VMAN ports can belong to load-sharing groups.

Guidelines for BlackDiamond X8 and 8000 Series Modules and Summit Family Switches. The following are VMAN configuration guidelines for BlackDiamond 8000 series modules, SummitStack, and Summit family switches:

- You can enable or disable jumbo frames before configuring VMANs. You can enable or disable jumbo frames on individual ports. See [Chapter 5, “Configuring Slots and Ports on a Switch,”](#) for more information on configuring jumbo frames.
- Spanning Tree Protocol (STP) operation on CVLAN components in a PEB as described in IEEE 802.1ad is *not* supported.
- The initial version of this feature does not implement an XML API.
- A VMAN with CEPs cannot be configured as a VPLS or VPWS Service VLAN.
- Multiple VMAN roles can be combined on one port with certain VLAN types as shown in [Table 68](#).

Table 68: Port Support for Combined VMAN Roles and VLANs

Platform	Combined CNP, CEP, and Tagged VLAN ^{a, b}	Combined PNP, CNP, and CEP ^{a, b, c}	Combined PNP and Tagged VLAN	Combined PNP and Untagged VLAN
Summit X150, X250e, X350, X450a, and X450e	X	X	X ^d	X
Summit X440, X460, X480, X650, and X670, and E4G-200 and E4G-400	X	X	X ^e	X
BlackDiamond 8500 and 8800 a-, c-, and e-series modules	X	X	X ^d	X
BlackDiamond X8, 8900 c-, xl-, and xm-series modules	X	X	X ^e	X

- a. Subsets of this group are also supported. That is, any two of these items are supported.
- b. When a CNP is combined with a CEP or tagged VLAN, any CVIDs not explicitly configured for a CEP or tagged VLAN are associated with the CNP.
- c. A PNP (tagged VMAN) and a CNP (untagged VMAN) or CEP cannot be combined on a port for which the selected VMAN ethertype is 0x8100.
- d. The VMAN ethertype must be set to 0x8100, which is different from the default value (0x88a8).
- e. If the secondary VMAN ethertype is selected for the port, it must be set to 0x8100.



NOTE

If you already configured VLANs and VMANs on the same module or stand-alone switch using ExtremeXOS 11.4, you cannot change the VMAN ethertype from 0X8100 without first removing either the VLAN or VMAN configuration.

Procedure for Configuring VMANs

This section describes the procedure for configuring VMANs. Before configuring VMANs, review [“Guidelines for Configuring VMANs”](#) on page 578.

To configure a VMAN, complete the following procedure at each switch that needs to support the VMAN:

- 1 If you are configuring a BlackDiamond 8800 series switch, a SummitStack, or a Summit family switch, enable jumbo frames on the switch.

**NOTE**

Because the BlackDiamond 8800 series switches, SummitStack, and the Summit family of switches enable jumbo frames switch-wide, you must enable jumbo frames before configuring VMANs on these systems.

- 2 Create a VMAN by entering the following command:

```
create vman <vman-name> {learning-domain} {vr <vr_name>}
```

- 3 Assign a tag value to the VMAN by entering the following command:

```
configure vman <vman-name> tag <tag>
```

- 4 To configure PNP ports on a PEB or PB, use the following command with the `tagged` option:

```
configure vman <vman-name> add ports [ all | <port_list> ] {untagged | tagged}
```

- 5 To configure CNP ports on a PEB, use the following command with the `untagged` option:

```
configure vman <vman-name> add ports [ all | <port_list> ] {untagged | tagged}
```

**NOTE**

You must configure CNP ports as `untagged` so that the S-tag is stripped from the frame on egress.

- 6 To configure CEP ports on a PEB, do the following:

- a Use the following command to establish a physical port as a CEP and configure CVID mapping and translation:

```
configure vman <vman_name> add ports <port_list> cep cvid <cvid_first> {-  
<cvid_last>} {translate <cvid_first_xlate> {- <cvid_last_xlate>}}
```

- b Use the following commands to add or delete CVIDs for a CEP and manage CVID mapping and translation:

```
configure vman <vman_name> ports <port_list> add cvid <cvid_first> {- <cvid_last>}  
{translate <cvid_first_xlate> {- <cvid_last_xlate>}}  
configure vman <vman_name> ports <port_list> delete cvid <cvid_first> {-  
<cvid_last>}
```

- c Use the following commands to manage CVID egress filtering for a CEP:

```
enable vman cep egress filtering ports {<port_list> | all}  
disable vman cep egress filtering ports {<port_list> | all}
```

- 7 Configure additional VMAN options as described in “Configuring VMAN Options” on page 580.
- 8 To configure a VLAN to use a VMAN, configure the VLAN on the switch port at the other end of the line leading to the VMAN access port.

Configuring VMAN Options

- [Configuring the Ethertype for VMAN Ports on page 581](#)
- [Configuring IGMP Snooping on a VMAN on page 581](#)
- [Selecting the Tag used for Egress Queue Selection on page 582](#)

- [Configuring Tag Translation and 1:N Flooding on page 582](#)

Configuring the Ethertype for VMAN Ports



NOTE

This feature is supported only on the platforms listed for this feature in the license tables in [Appendix A, “Feature License Requirements.”](#)

The ethertype is a component of VLAN and VMAN frames and is introduced in [“Secondary Ethertype Support” on page 576.](#)

To configure the ethertype for VMAN (PBN) ports, do the following:

- 1 Configure the primary and secondary (if needed) VMAN ethertype values for the switch using the following command:

```
configure vman ethertype <value> [primary | secondary]
```

By default, all VMAN ports use the primary ethertype value.

- 2 If you plan to use a secondary ethertype, select the secondary ethertype for the appropriate VMAN ports using the following command:

```
configure port <port_list> ethertype {primary | secondary}
```

Configuring IGMP Snooping on a VMAN

Internet Group Management Protocol (IGMP) snooping is introduced in [“IGMP Snooping” on page 1411,](#) and is enabled by default on all VLANs and VMANs. IGMP snooping allows a switch to forward Layer 2 multicast traffic within a VMAN to only those destinations that require it.

To use IGMP snooping on a VMAN, you must enable IP multicasting on the VMAN. If your topology requires a separate VLAN for multicast traffic, some platforms support multicast traffic on VLAN and VMANs on the same port. The BlackDiamond X8 and 8800 series switches, SummitStack, and Summit family switches support multicast traffic on VLANs and VMANs that share the same port.

To configure multicast support for both a VMAN and a VLAN on the same port of a BlackDiamond X8 and 8800 series switch, a SummitStack, or a Summit family switch, use the following procedure:

- 1 Enable jumbo frames on the switch (not required on BlackDiamond 20800 series switches).
- 2 Change the VMAN ethertype to 0x8100 as described in [“Configuring the Ethertype for VMAN Ports” on page 581.](#)
- 3 Assign different IP addresses to the VLAN and the VMAN.
- 4 Enable IP forwarding on both the VLAN and the VMAN.
- 5 Enable IP multicasting forwarding on both the VLAN and the VMAN.
- 6 Configure IGMP on both the VLAN and the VMAN.



NOTE

See [Chapter 39, “Multicast Routing and Switching,”](#) for information on configuring and using multicasting.

After you enable multicast forwarding on the VMAN, you can configure and use IGMP snooping.

Selecting the Tag used for Egress Queue Selection



NOTE

This feature is supported and configurable only on the platforms listed for this feature in the license tables in [Appendix A, “Feature License Requirements.”](#)

By default, switches that support the enabling and disabling of this feature use the 802.1p value in the S-tag to direct the packet to the queue on the egress port.

To configure egress queue dot1p examination of the C-tag, use the following command:

```
enable dot1p examination inner-tag port [all | <port_list>]
```

To return to the default selection of using the 802.1p value in the S-tag, use the following command:

```
disable dot1p examination inner-tag ports [all | <port_list>]
```



NOTE

See [Chapter 20, “QoS,”](#) for information on configuring and displaying the current 802.1p and DiffServ configuration for the S-tag 802.1p value.

Configuring Tag Translation and 1:N Flooding

- [Creating a Learning Domain on page 582](#)

Creating a Learning Domain. To create and configure a learning domain, use the following procedure:

- 1 Create the learning domain VMAN by entering the following command:

```
create vman <vman-name> {learning-domain} {vr <vr_name>}
```

- 2 Assign a tag value to the learning domain VMAN by entering the following command:

```
configure vman <vman-name> tag <tag>
```

- 3 Use the following command to add all the ports added in the flood group as *tagged* or *untagged* to the learning-domain:

```
configure vman <vman-name> add ports [all | <port_list>] {untagged | tagged}
```



NOTE

The port type (tagged or untagged) should match the port type specified in the flood-group.

Displaying Information

This section discusses the following topics:

- [Displaying VMAN Information on page 583](#)
- [Configuration Examples on page 583](#)

Displaying VMAN Information

To display information on one or all VMANs, use the following commands:

```
show vman
show {vman} <vman_name> {ipv4 | ipv6}
show vman [tag <tag> | detail] {ipv4 | ipv6}
show {vman} <vman_name> eaps
```



NOTE

The display for the `show vman` command is different depending on the platform and configuration you are using. See the ExtremeXOS Command Reference Guide for complete information on this command.

You can also display VMAN information, as well as all the VLANs, by issuing the `show ports information detail` command.

To display the ethertype for a VMAN, use the following command:

```
show vman etherType
```

Configuration Examples

This section provides the following examples:

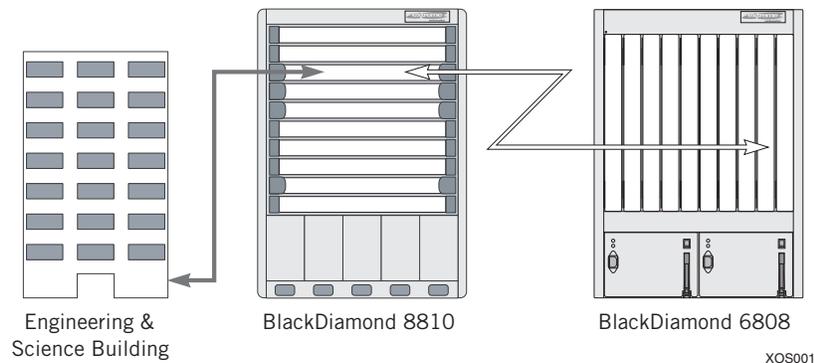
- [VMAN Example, BlackDiamond 8810 on page 584](#)
- [VMAN CEP Example on page 585](#)
- [VMAN CEP Example on page 585](#)
- [LAG Port Selection Example on page 586](#)
- [Multiple VMAN Ethertype Example on page 587](#)
- [Tag Translation Example Using ACLs Only on page 588](#)

- [1:N Flooding Examples on page 589](#)
- [PBBN Example on page 591](#)

VMAN Example, BlackDiamond 8810

The following example shows the steps to configure a VMAN (PBN) on the BlackDiamond 8810 switch shown in [Figure 78](#).

Figure 78: Sample VMAN Configuration on BlackDiamond 8810 Switch



The VMAN is configured from the building to port 1, slot 3 on the BlackDiamond 8810 switch and from port 2, slot 3 on the BlackDiamond 8810 switch to the BlackDiamond® 6808 switch:

```
enable jumbo frames
create vman vman_tunnel_1
configure vman vman_tunnel_1 tag 100
configure vman vman_tunnel_1 add port 3:1 untagged
configure vman vman_tunnel_1 add port 3:2 tagged
enable dot1p examination inner-tag port 3:2
```

The following example configuration demonstrates configuring IP multicast routing between VMANs and VLANs (when VMAN traffic is not double-tagged) on the BlackDiamond 8800 series switch and the Summit family of switches. Using this configuration you can use a common uplink to carry both VLAN and VMAN traffic and to provide multicast services from a VMAN through a separate VLAN (notice that port 1:1 is in both a VLAN and a VMAN):

```
enable jumbo-frame ports all
configure vman ethertype 0x8100
create vlan mc_vlan
configure vlan mc_vlan tag 77
create vman vman1
configure vman vman1 tag 88
configure vlan vman1 ipaddress 10.0.0.1/24
configure vlan mc_vlan ipaddress 11.0.0.1/24
enable ipforwarding vman1
enable ipforwarding mc_vlan
enable ipmcforwarding vman1
enable ipmcforwarding mc_vlan
configure vlan mc_vlan add port 1:1 tag
configure vman vman1 add port 1:1 tag
configure vman vman1 add port 2:1, 2:2, 2:3
```

**NOTE**

IGMP reports can be received untagged on ports 2:1, 2:2, and 2:3. Tagged IP multicast data is received on mc_vlan port 1:1 and is routed using IP multicasting to vman1 ports that subscribe to the IGMP group.

**NOTE**

IGMP snooping (Layer 2 IP multicasting forwarding) does not work on the VMAN ports because there is no double-tagged IP multicast cache lookup capability from port 1:1.

VMAN CEP Example

The following configuration configures a VMAN CEP to support up to 10 customer VLANs for each of three VMANs.

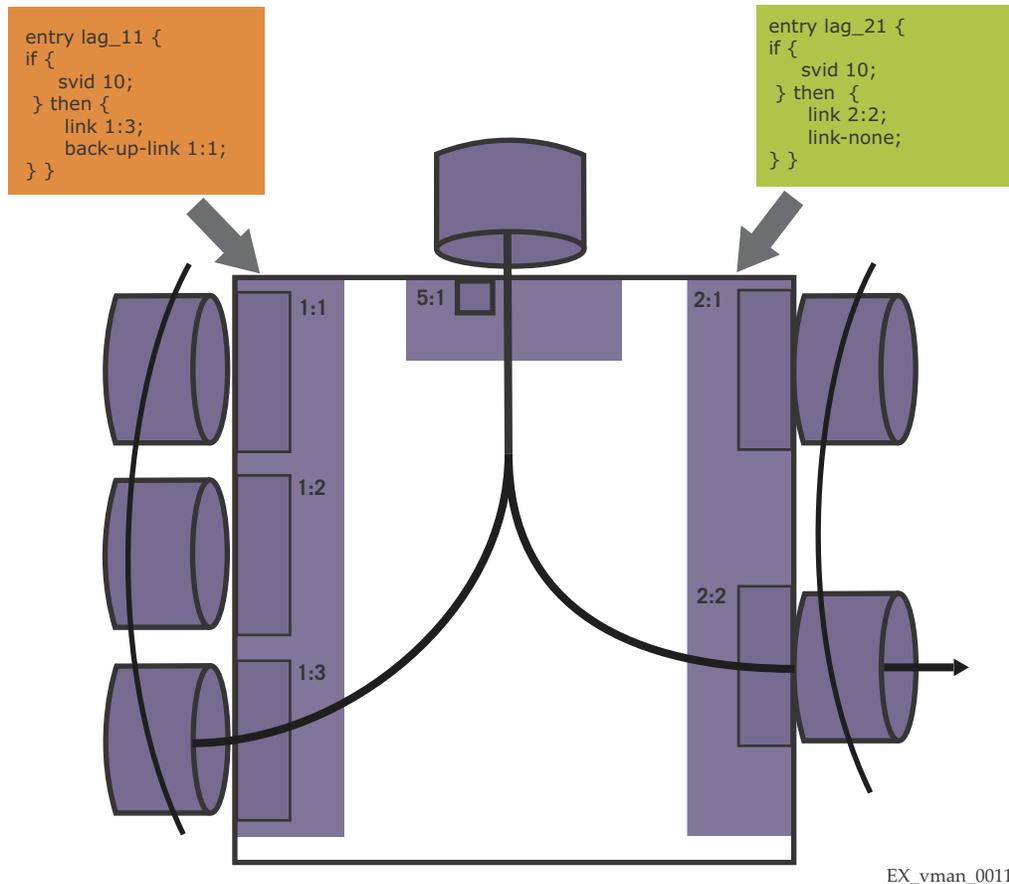
```
create vman cust1
create vman cust2
create vman cust3
config vman cust1 tag 1000
config vman cust2 tag 1001
config vman cust3 tag 1002
config vman cust1 add port 22 tag
config vman cust2 add port 22 tag
config vman cust3 add port 23 tag
config vman cust1 add port 1 cep cvid 100 - 109 translate 200 - 209
config vman cust2 add port 1 cep cvid 110 - 119 translate 210 - 219
config vman cust3 add port 1 cep cvid 120 - 129 translate 220 - 229
enable vman cep egress filtering ports 1
```

Port 1 serves as the CEP, and egress filtering is enabled on the port. Ports 22 and 23 serve as CNPs, providing the connection between the CEP port and the rest of each VMAN.

LAG Port Selection Example

The following example shows the steps to configure LAG filtering using a VMAN (PBN) egress ACL as shown in [Figure 79](#).

Figure 79: LAG Filtering Using VMAN Egress ACL Example



To create the configuration shown in [Figure 79](#), use the following commands:

```

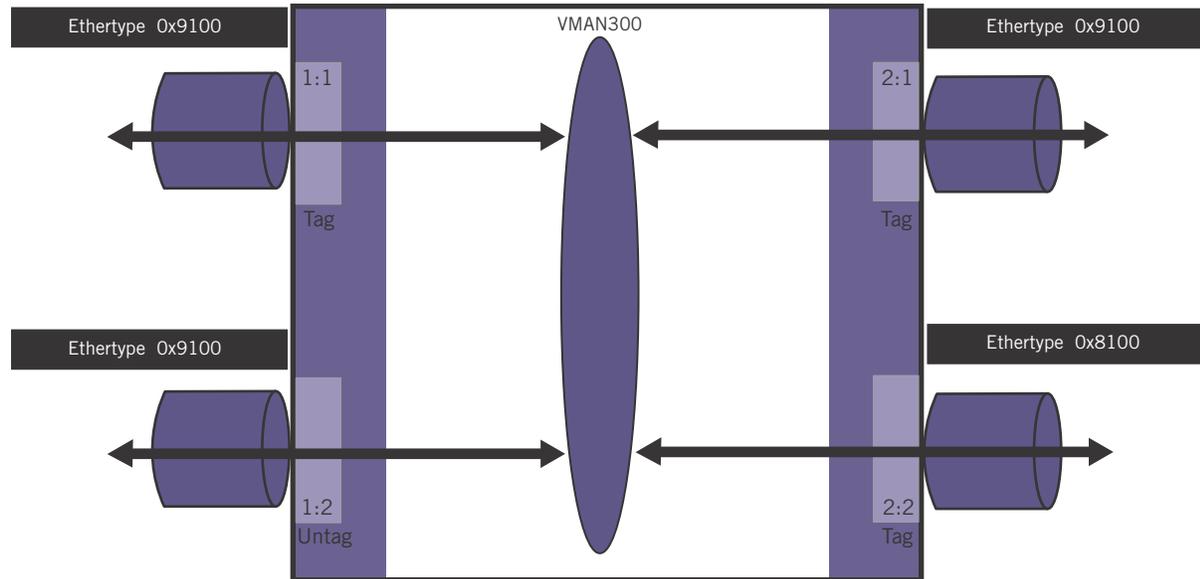
# create vman vman10
# configure vman vman10 tag 10
#
# enable sharing 1:1 grouping 1:1, 1:2, 1:3 algorithm port-based
# enable sharing 2:1 grouping 2:1, 2:2 algorithm port-based
#
# configure vman vman10 add port 1:1, 2:1, 5:1 tagged
#
# configure access-list lag_11 port 1:1 egress
# configure access-list lag_21 port 2:1 egress

```

Multiple VMAN Ethertype Example

Figure 80 shows a switch that is configured to support the primary ethertype on three ports and the secondary ethertype on a fourth port. The primary VMAN (PBN) ethertype is changed from the default value, but that is not required.

Figure 80: Multiple VMAN Ethertype Example



EX_vman_0031

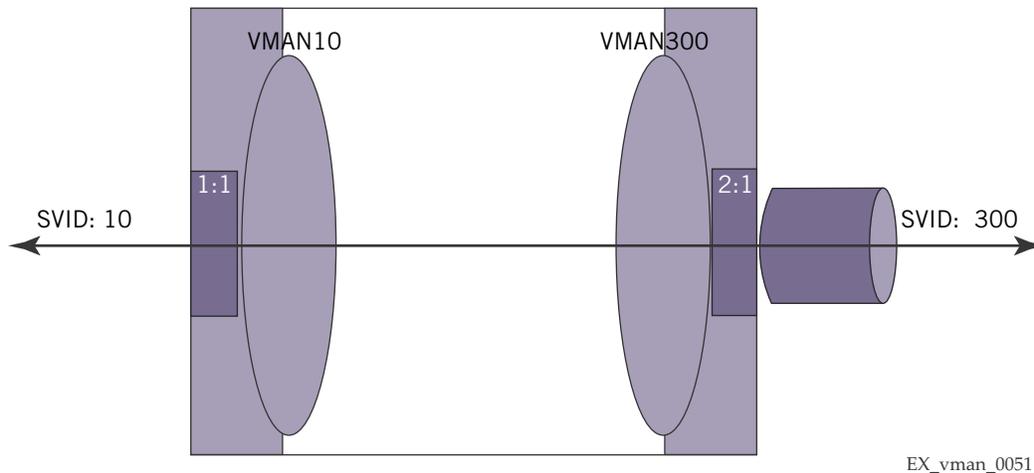
The following configuration commands accomplish what is shown in Figure 80:

```
# configure vman ethertype 0x9100 primary
# configure vman ethertype 0x8100 secondary
#
# configure port 2:2 ethertype secondary
#
# create vman vman300
# configure vman vman300 tag 300
#
# configure vman vman300 add port 1:1, 2:1, 2:2 tagged
# configure vman vman300 add port 1:2 untagged
```

Tag Translation Example Using ACLs Only

Figure 81 shows a BlackDiamond 12800 series switch that is configured to support tag translation using ACLs. Ingress ACLs on ports 1:1 and 2:1 implement the tag translation.

Figure 81: S-Tag Translation Example Using ACLs Only



The following commands configure everything except the ACLs for the example shown in Figure 81:

```
# create vman vman10
# configure vman vman10 tag 10
# configure vman vman10 add port 1:1 tagged

# create vman vman300
# configure vman vman300 tag 300
# configure vman vman300 add port 2:1 tagged

# configure access-list port_11_i port 1:1 ingress
# configure access-list port_21_i port 2:1 ingress
```

The following is the ingress ACL for port 1:1 in Figure 81:

```
# entry port_11_i {
if {
    svid 10;
} then {
    svid 300;
} }
```

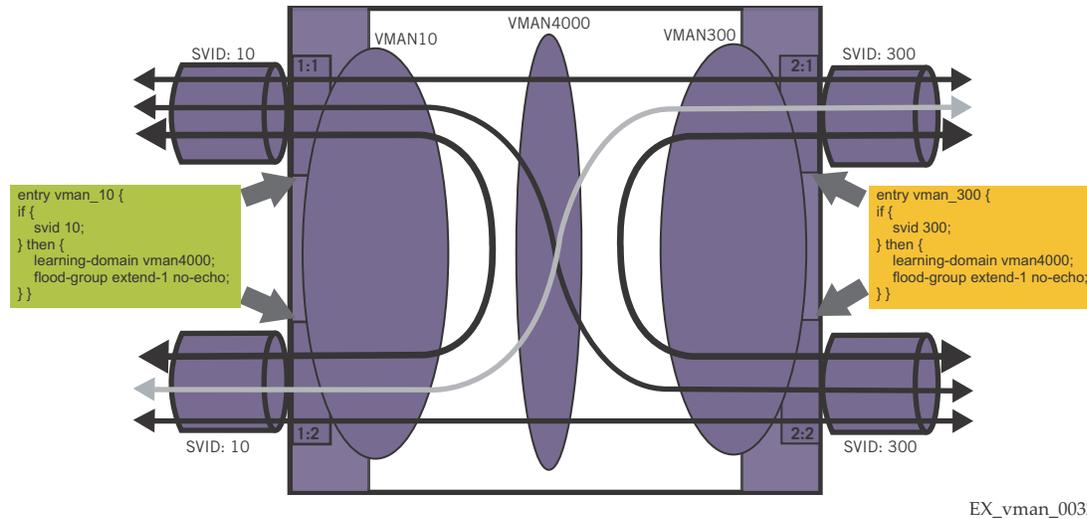
The following is the ingress ACL for port 2:1 in Figure 81:

```
entry port_21_i {
if {
    svid 300;
} then {
    svid 10;
} }
```

1:N Flooding Examples

The following example shows the steps to configure 1:N flooding using a VMAN (PBN) ingress ACL as shown in [Figure 82](#).

Figure 82: Sample 1:N Flooding Using VMAN Ingress ACL (Using Extended Flood Groups)



To create the configuration shown in [Figure 82](#), use the following commands:

```

create vman vman10
# configure vman vman10 tag 10
# configure vman vman10 add port 1:1, 1:2 tagged
#
# create vman vman300
# configure vman vman300 tag 300
# configure vman vman300 add port 2:1, 2:2 tagged
#
# create vman vman4000 learning-domain
# configure vman vman4000 tag 4000
# configure vman vman4000 add port 1:1, 1:2, 2:1, 2:2 tag

# create flood-group extended extend-1
# configure flood-group ext extend-1 add vman10 port all
# configure flood-group ext extend-1 add vman300 port all
#

```

The following is the ingress ACL for ports 1:1 and 1:2:

```

entry vman_10 {
  if {
    svid 10;
  } then {
    learning-domain vman4000;
    flood-group extend-1 no-echo;
  }
}

```

The following is the ingress ACL for ports 2:1 and 2:2:

```

entry vman_300 {
  if {
    svid 300;
  }
}

```

```

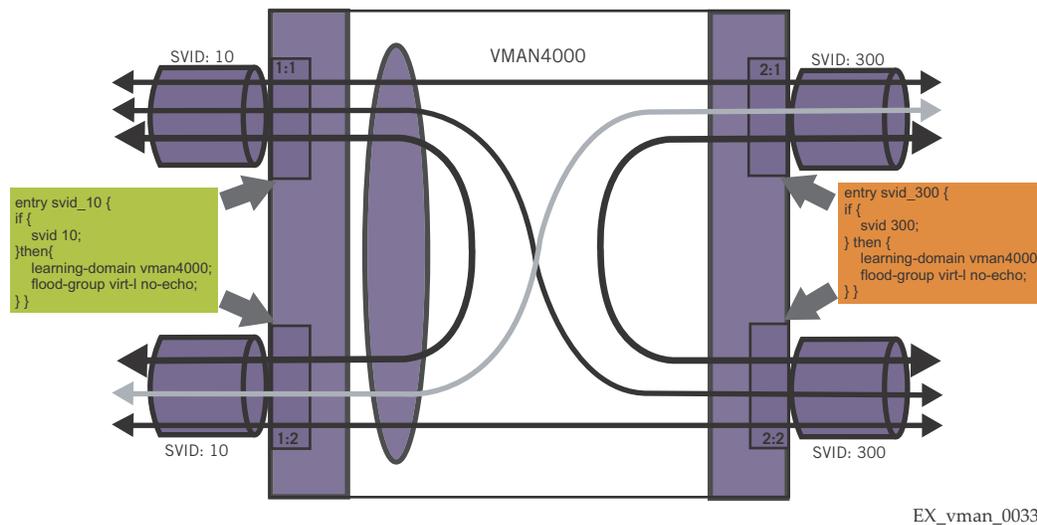
} then {
learning-domain vman4000;
flood-group extend-1 no-echo;
} }

#configure access-list vman_10 port 1:1, 1:2 ingress
#
# configure access-list vman_300 port 2:1, 2:2 ingress

```

An alternate method for this configuration is shown in [Figure 83](#).

Figure 83: Sample 1:N Flooding Using VMAN Ingress ACL—Alternative (Using Virtual Flood Groups)



To create the configuration shown in [Figure 83](#), use the following commands:

```

# create vman vman4000 learning-domain
# configure vman vman4000 tag 4000
# configure vman vman4000 add port 1:1, 1:2, 2:1, 2:2 tagged

# create flood-group virtual virt-1
# configure flood-group vir virt-1 add stag 10 port 1:1
# configure flood-group vir virt-1 add stag 10 port 1:2
# configure flood-group vir virt-1 add stag 300 port 2:1
# configure flood-group vir virt-1 add stag 300 port 2:2

```

The following is the ingress ACL for ports 1:1 and 1:2:

```

entry svid_10 {
if {
svid 10;
} then {
learning-domain vman4000;
flood-group virt-1 no-echo;
} }

```

The following is the ingress ACL for ports 2:1 and 2:2:

```

entry svid_300 {
if {
svid 300;
}

```

```

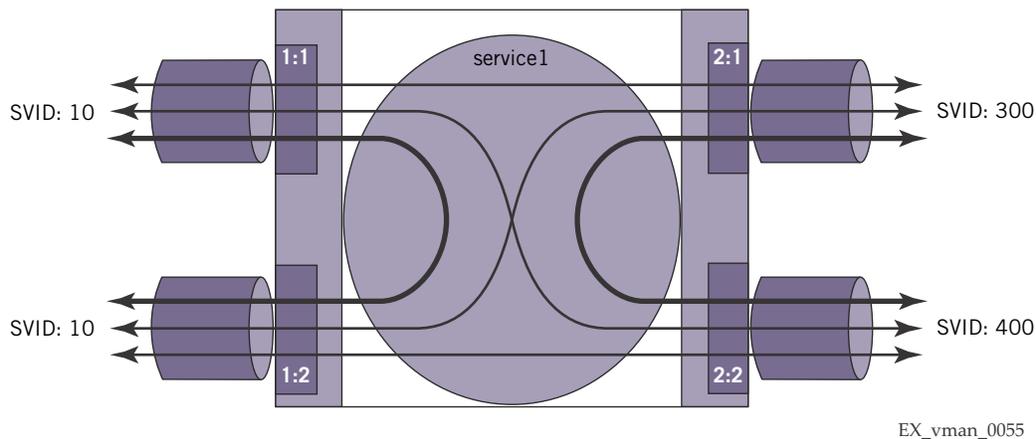
} then {
learning-domain vman4000;
flood-group virt-1 no-echo;
} }

#configure access-list svid_10 port 1:1, 1:2 ingress
#
# configure access-list svid_300 port 2:1, 2:2 ingress

```

Figure 84 shows an example configuration for tag translation and 1:N flooding on BlackDiamond 20800 series switches.

Figure 84: Tag Translation and 1:N Flooding on BlackDiamond 20800 Switches



To configure the example shown in Figure 84, enter the following commands:

```

#create vman service1
# configure vman service1 tag 10
# configure vman service1 add port 1:1, 1:2 tagged

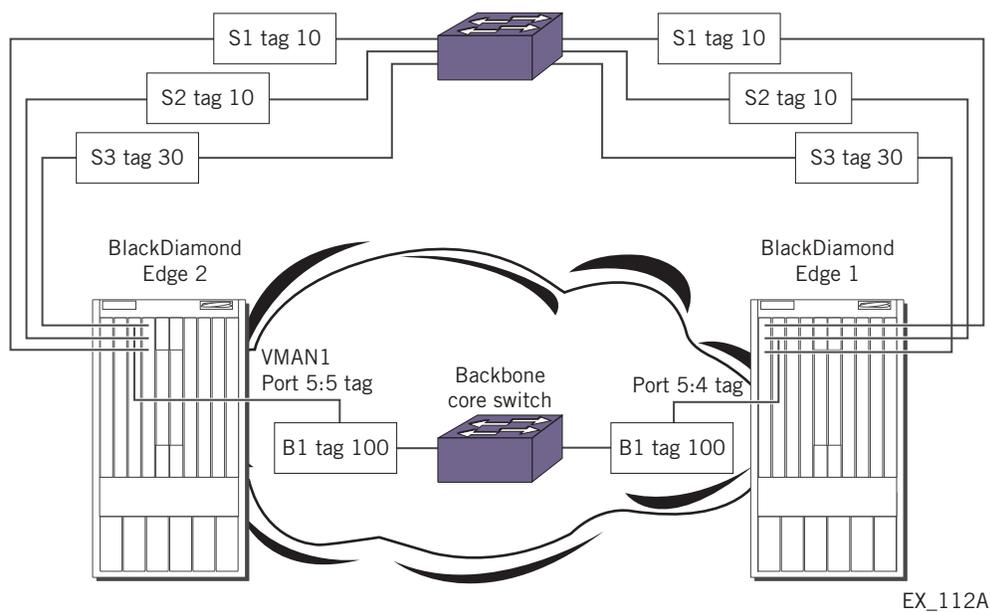
# configure vman service1 add port 2:1 svid 300

# configure vman service1 add port 2:2 svid 400

```

PBBN Example

The example shown in Figure 85 illustrates a PBBN. In this example, three ISPs, each with multiple customers, are using one PBBN from the backbone provider. S1, S2, and S3 represent the three ISPs (again, each has its own customers running through that SVLAN), and all are using the one BVLAN, B1, through the core backbone.

Figure 85: PBBN Configuration Example**NOTE**

You must enable jumbo frames on all ports before configuring a PBBN.

The following sections describe the configuration of each switch in [Figure 85](#):

- [Backbone Core Switch Configuration on page 592](#)

Backbone Core Switch Configuration

After configuration, the Backbone Core Switch has the following configuration:

- Port 5:4 is connected to edge switch 1, BVLAN b1, port 2:2.
- Port 5:5 is connected to edge switch 2, BVLAN b1, port 3:2.

To create this configuration, use the following commands:

```
create vman vman1
configure vman vman1 tag 100
configure vman vman1 add port 5:4-5 tagged
```

14

CHAPTER

FDB

This chapter includes the following sections:

- [Overview on page 593](#)
- [Managing the FDB on page 596](#)
- [Displaying FDB Entries and Statistics on page 600](#)
- [MAC-Based Security on page 600](#)
- [Managing MAC Address Tracking on page 604](#)

Overview



NOTE

See the ExtremeXOS Command Reference Guide for details of the commands related to the FDB.

The switch maintains a forwarding database (FDB) of all MAC addresses received on all of its ports. It uses the information in this database to decide whether a frame should be forwarded or filtered.

This section describes the following topics:

- [FDB Contents on page 593](#)
- [How FDB Entries Get Added on page 594](#)
- [FDB Entry Types on page 594](#)

FDB Contents

Each Forwarding Database (FDB) entry consists of:

- The MAC address of the device
- An identifier for the port and VLAN on which it was received
- The age of the entry
- Flags

Frames destined for MAC addresses that are not in the FDB are flooded to all members of the VLAN.

How FDB Entries Get Added

The MAC entries that are added to the FDB are learned in the following ways:

- Source MAC entries are learned from ingress packets on all platforms. This is Layer 3 learning.
- On BlackDiamond 8800 series switches, MAC entries can be learned at the hardware level.
- Virtual MAC addresses embedded in the payload of IP ARP packets can be learned when this feature is enabled.
- Static entries can be entered using the command line interface (CLI).
- Dynamic entries can be modified using the command line interface (CLI).
- Static entries for switch interfaces are added by the system upon switch boot-up.

The ability to learn MAC addresses can be enabled or disabled on a port-by-port basis. You can also limit the number of addresses that can be learned, or you can *lock down* the current entries and prevent additional MAC address learning.

BlackDiamond 8000 series modules and Summit switches support different FDB table sizes. On a BlackDiamond 8800 switch with a variety of modules or on a SummitStack with different Summit switch models, the FDB tables on some modules or switches can be filled before the tables on other modules or switches. In this situation, when a lower-capacity FDB table cannot accept FDB entries, a message appears that is similar to the following:

```
HAL.FDB.Warning> MSM-A: FDB for vlanID1 mac 00:00:03:05:15:04 was not added to slot 3  
- table full.
```



NOTE

For information on increasing the FDB table size on BlackDiamond 8900 xl-series modules and Summit X480 switches, see [“Increasing the FDB Table Size” on page 596](#). For information on FDB tables sizes, see the ExtremeXOS Release Notes.

FDB Entry Types

The following sections describes the types of entries that can exist in the FDB:

- [Dynamic Entries on page 594](#)
- [Static Entries on page 595](#)
- [Blackhole Entries on page 596](#)
- [Private VLAN Entries on page 596](#)

Dynamic Entries

A dynamic entry is learned by the switch by examining packets to determine the source MAC address, VLAN, and port information. The switch then creates or updates an FDB entry for that MAC address. Initially, all entries in the database are dynamic, except for certain entries created by the switch at boot-up.

Entries in the database are removed (aged-out) if, after a period of time (aging time), the device has not transmitted. This prevents the database from becoming full with obsolete entries by ensuring that when

a device is removed from the network, its entry is deleted from the database. The aging time is configurable, and the aging process operates on the supported platforms as follows:

- On all platforms, you can configure the aging time to 0, which prevents the automatic removal of all dynamic entries.
- On BlackDiamond X8 series switches, BlackDiamond 8000 a-, c-, e- and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit X150, X250e, X350, X440, X450, X460, X650 and X670 series switches, the aging process takes place in software and the aging time is configurable.
- On BlackDiamond 8900 xl-series and Summit X480 switches, the aging process takes place in hardware and the aging time is based on (but does not match) the configured software aging time.

For more information about setting the aging time, see [“Configuring the FDB Aging Time” on page 598](#).



NOTE

If the FDB entry aging time is set to 0, all dynamically learned entries in the database are considered static, non-aging entries. This means that the entries do not age, but they are still deleted if the switch is reset.

Dynamic entries are flushed and relearned (updated) when any of the following take place:

- A VLAN is deleted.
- A VLAN identifier (VLANid) is changed.
- A port mode is changed (tagged/untagged).
- A port is deleted from a VLAN.
- A port is disabled.
- A port enters blocking state.
- A port goes down (link down).

A *non-permanent dynamic entry* is initially created when the switch identifies a new source MAC address that does not yet have an entry in the FDB. The entry can then be updated as the switch continues to encounter the address in the packets it examines. These entries are identified by the “d” flag in `show fdb` command output.

Static Entries

A static entry does not age and does not get updated through the learning process. A static entry is considered permanent because it is retained in the database if the switch is reset or a power off/on cycle occurs. A static entry is maintained exactly as it was created. Conditions that cause dynamic entries to be updated, such as VLAN or port configuration changes, do not affect static entries.

To create a permanent static FDB entry, see [“Adding a Permanent Unicast Static Entry” on page 596](#).

If a duplicate MAC address is learned on a port other than the port where the static entry is defined, all traffic from that MAC address is dropped. By default, the switch does not report duplicate addresses. However, you can configure the switch to report these duplicate addresses as described in [“Managing Reports of Duplicate MAC Addresses for Static Entries” on page 598](#).

A *locked static entry* is an entry that was originally learned dynamically, but has been made static (locked) using the MAC address lock-down feature. It is identified by the “s,” “p,” and “l” flags in `show fdb` command output and can be deleted using the `delete fdbentry` command. See [“MAC Address Lockdown” on page 838](#) for more information about MAC address lock-down.

**NOTE**

Static FDB entries created on EAPS- or STP-enabled ports forward traffic irrespective of the port state. Consequently, you should avoid such a configuration.

Blackhole Entries

A blackhole entry configures the switch to discard packets with a specified MAC destination address. Blackhole entries are useful as a security measure or in special circumstances where a specific source or destination address must be discarded. Blackhole entries can be created through the CLI, or they can be created by the switch when a port's learning limit has been exceeded.

Blackhole entries are treated like permanent entries in the event of a switch reset or power off/on cycle. Blackhole entries are never aged out of the database.

Private VLAN Entries

A Private VLAN (PVLAN) creates special FDB entries that are described in “[MAC Address Management in a PVLAN](#)” on page 544.

Managing the FDB

This section describes the following topics:

- [Increasing the FDB Table Size on page 596](#)
- [Adding a Permanent Unicast Static Entry on page 596](#)
- [Adding a Permanent Multicast Static Entry on page 597](#)
- [Configuring the FDB Aging Time on page 598](#)
- [Adding Virtual MAC Entries from IP ARP Packets on page 598](#)
- [Managing Reports of Duplicate MAC Addresses for Static Entries on page 598](#)
- [Clearing FDB Entries on page 599](#)
- [Supporting Remote Mirroring on page 599](#)

Increasing the FDB Table Size

BlackDiamond 8900 xl-series modules and Summit X480 switches provide an additional table that can be configured to support additional FDB table entries with the following command:

```
configure forwarding external-tables [l3-only {ipv4 | ipv4-and-ipv6 | ipv6} | l2-only  
| acl-only | l2-and-l3 | l2-and-l3-and-acl | l2-and-l3-and-ipmc | none]
```

Adding a Permanent Unicast Static Entry

To add a static entry, use the following command:

```
create fdbentry <mac_addr> vlan <vlan_name> [ports <port_list> | blackhole]
```

The following example adds a permanent static entry to the FDB:

```
create fdbentry 00:E0:2B:12:34:56 vlan marketing port 3:4
```

The permanent entry has the following characteristics:

- MAC address is 00:E0:2B:12:34:56.
- VLAN name is *marketing*.
- Slot number for this device is 3 (only on modular switches).
- Port number for this device is 4.

On Summit family switches, BlackDiamond X8 series switches, and BlackDiamond 8000 series modules, you can specify multiple ports when you create a unicast static entry. However, all ports in the list must be on the same SummitStack switch, BlackDiamond X8 series switch or BlackDiamond 8000 series module. When the port list contains ports on different slots, the following error is generated:

```
Error: Multiple ports must be on the same slot for unicast MAC FDB entries.
```

Once the multiport static FDB entry is created, any ingress traffic with a destination MAC address matching the FDB entry is multicasted to each port in the specified list. On Summit family switches and BlackDiamond 8000 series modules, if the FDB entry is the next hop for an IP adjacency, unicast routing sends the packet to the first port in the list.



NOTE

When a multiport list is assigned to a unicast MAC address, load sharing is not supported on the ports in the multiport list.

Summit family switches, BlackDiamond X8 series switches, and BlackDiamond 8000 series modules do not support this multiport feature natively using the FDB table. Instead, for each FDB entry of this type, a series of system ACLs have been installed which match the specified MAC address and VLAN ID, and override the egress port forwarding list with the supplied list of ports. Multiple ACLs per FDB are required to handle Layer 2 echo kill by installing a unique ACL per individual port in the list to send matching traffic to all other ports in the list.

User-configured ACLs take precedence over these FDB-generated ACL rules, and the total number of rules is determined by the platform. The hardware ACL limitations for each platform are described in [Chapter 18, “ACLs.”](#)

Adding a Permanent Multicast Static Entry

On BlackDiamond X8 series switches, BlackDiamond 8000 series modules, SummitStack, and Summit family switches, you can create FDB entries to multicast MAC addresses (that is, 01:00:00:00:00:01) and list one or more ports. Use the `create fdbentry <mac_addr> vlan <vlan_name> [ports <port_list> | blackhole]` command to enter the multicast FDB address. After traffic with a multicast MAC destination address enters the switch, that traffic is multicast to all ports on the list.

However, if the MAC address is in the IP multicast range (for example, 01:00:5e:XX:XX:XX), IGMP snooping rules take precedence over the multicast static FDB entry. Of course, if you disable IGMP snooping on *all* VLANs, the static FDB entry forwards traffic.

Configuring the FDB Aging Time

You configure the aging time for dynamic FDB entries using the following command:

```
configure fdb agingtime <seconds>
```

If the aging time is set to 0, all aging entries in the database are defined as static, nonaging entries. This means the entries will not age out, but non-permanent static entries can be deleted if the switch is reset.

To display the aging time, use the following command:

```
show fdb
```



NOTE

On BlackDiamond 8900 xl-series and Summit X480 switches, FDB entries are aged in hardware, the aging time is always displayed as 000, and the h flag is set for entries that are hardware aged.

Adding Virtual MAC Entries from IP ARP Packets

Generally, the FDB is programmed with the source MAC address of frames that contain an IP ARP payload. MAC entries present in the ARP payload as *Sender-MAC* are not learned. When IP ARP Sender-MAC learning is enabled, the switch learns both the source MAC address and the Sender-MAC from the ARP payload, and the switch programs these MAC addresses in the FDB.

This feature is useful when you want the switch to learn the Sender-MAC address for a redundant protocol, such as VRRP. For example, if your network has a gateway with a virtual MAC address, the switch learns the system MAC address for the gateway. If you enable the IP ARP Sender-MAC learning feature, the switch also learns the virtual MAC address embedded in IP ARP packets for the gateway IP address.

To enable the IP ARP sender-MAC learning feature, use the following command:

```
enable learning iparp sender-mac
```

To view the configuration of this feature, use the following command:

```
show iparp
```

To disable this feature, use the following command:

```
disable learning iparp sender-mac
```

Managing Reports of Duplicate MAC Addresses for Static Entries

By default, if a MAC address that is a duplicate of a static MAC address entry is learned on another port (other than the port where the static MAC address is configured), traffic from the duplicate address is silently dropped.

To enable or disable EMS and SNMP reporting of duplicate addresses for static entries, use the following commands:

```
enable fdb static-mac-move  
disable fdb static-mac-move
```

To control the number of EMS and SNMP reports per second issued, use the following command:

```
configure fdb static-mac-move packets <count>
```

To display the configuration of this feature, use the following command:

```
show fdb static-mac-move configuration
```

Clearing FDB Entries

You clear dynamic and permanent entries using different CLI commands.

You clear dynamic FDB entries by targeting:

- Specified MAC addresses
- Specified ports
- Specified VLANs,
- All blackhole entries

To clear dynamic entries from the FDB, use the following command:

```
clear fdb {<mac_addr> | ports <port_list> | vlan <vlan_name> | blackhole}
```

You clear permanent FDB entries by targeting:

- All permanent entries
- Specified MAC addresses
- Specified VLANs
- All blackhole entries

To clear permanent entries from the FDB, use the following command:

```
delete fdbentry [all | <mac_address> [vlan <vlan name>]
```

Supporting Remote Mirroring

The remote mirroring feature copies select traffic from select ports and VLANs and sends the copied traffic to a remote switch for analysis. The mirrored traffic is sent using a VLAN that is configured for this purpose. For more information, see [“Table 31 shows additional MLAG requirements that are specific to other protocols and features.”](#) on page 302.

Transit switches are the switches between the source switch where ports are mirrored and the destination switch where the mirrored traffic exits the network to a network analyzer or network storage device. Because the mirrored traffic is an exact copy of the real traffic, a transit switch can learn the MAC addresses and make incorrect forwarding decisions.

Displaying FDB Entries and Statistics

The following sections describe commands to display FDB entries and statistics:

- [Displaying FDB Entries on page 600](#)
- [Displaying FDB Statistics on page 600](#)

Displaying FDB Entries

To display FDB entries, use the following command:

```
show fdb {blackhole {netlogin [all | mac-based-vlans]} | netlogin [all | mac-based-
vlans] | permanent {netlogin [all | mac-based-vlans]} | <mac_addr> {netlogin [all |
mac-based-vlans]} | ports <port_list> {netlogin [all | mac-based-vlans]} | vlan
<vlan_name> {netlogin [all | mac-based-vlans]} | {{vpls} {<vpls_name>}}}
```



NOTE

The MAC-based VLAN netlogin parameter applies only for Summit family switches and BlackDiamond 8800 series switches. See [Chapter 21, “Network Login,”](#) for more information on netlogin.

With no options, this command displays all FDB entries. (The age parameter does not show on the display for the backup MSM/MM on modular switches; it *does* show on the display for the primary MSM/MM.)

Displaying FDB Statistics

To display FDB statistics, use the following command:

```
show fdb stats {{ports {all | <port_list>} | vlan {all} | {vlan} <vlan_name> } {no-
refresh}}
```

With no options, this command displays summary FDB statistics.

MAC-Based Security

MAC-based security allows you to control the way the FDB is learned and populated. By managing entries in the FDB, you can block and control packet flows on a per-address basis.

MAC-based security allows you to limit the number of dynamically-learned MAC addresses allowed per virtual port. You can also “lock” the FDB entries for a virtual port, so that the current entries will not change, and no additional addresses can be learned on the port.

You can also prioritize or stop packet flows based on the source MAC address of the ingress VLAN or the destination MAC address of the egress VLAN.



NOTE

For detailed information about MAC-based security, see [Chapter 23, “Security.”](#)

This section describes the following topics:

- [Managing MAC Address Learning on page 601](#)
- [Managing Egress Flooding on page 602](#)
- [Displaying Learning and Flooding Settings on page 603](#)
- [Creating Blackhole FDB Entries on page 603](#)

Managing MAC Address Learning

By default, MAC address learning is enabled on all ports. MAC addresses are added to the FDB as described in [“How FDB Entries Get Added” on page 594](#).

When MAC address learning is disabled on a port, the switch no longer stores the source address information in the FDB. However, the switch can still examine the source MAC address for incoming packets and either forward or drop the packets based on this address. The source address examination serves as a preprocessor for packets. Forwarded packets are forwarded to other processes, not to other ports. For example, if the switch forwards a packet based on the source address, the packet can still be dropped based on the destination address or the egress flooding configuration.

When MAC address learning is disabled, the two supported behaviors are labeled as follows in the software:

- forward-packets
- drop-packets

The drop-packets behavior is supported on BlackDiamond 8000 series modules, SummitStack, and Summit family switches. When the drop-packets option is chosen, EDP packets are forwarded, and all unicast, multicast, and broadcast packets from a source address not in the FDB are dropped. No further processing occurs for dropped packets.

The disable learning forward-packets option saves switch resources (FDB space), however, it can consume network resources when egress flooding is enabled. When egress flooding is disabled or the drop-packet option is specified, disabling learning adds security by limiting access to only those devices listed in the FDB.

To disable learning on specified ports, use the following command:

```
disable learning {drop-packets | forward-packets} port [<port_list> | all]
```



NOTE

The drop-packets and forward-packets options are available only on the BlackDiamond 8800 series switches, SummitStack, and the Summit family switches. If neither option is specified, the drop-packets behavior is selected.

To enable learning on specified ports, use the following command:

```
enable learning {drop-packets} ports [all | <port_list>]
```

Managing Egress Flooding

Egress flooding takes action on a packet based on the packet destination MAC address. By default, egress flooding is enabled, and any packet for which the destination address is not in the FDB is flooded to all ports except the ingress port.

You can enhance security and privacy as well as improve network performance by disabling Layer 2 egress flooding on a port, VLAN, or VMAN. This is particularly useful when you are working on an edge device in the network. Limiting flooded egress packets to selected interfaces is also known as upstream forwarding.

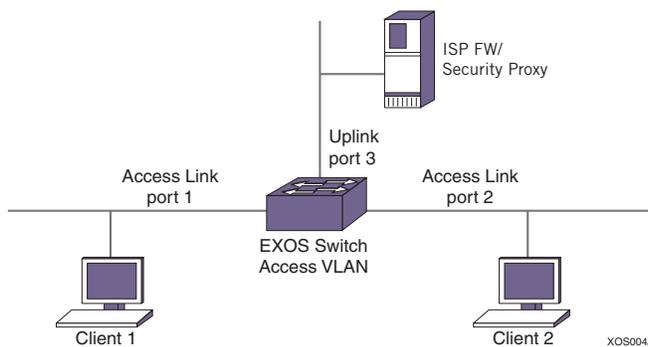


NOTE

Disabling egress flooding can affect many protocols, such as IP and ARP.

Figure 86 illustrates a case where you want to disable Layer 2 egress flooding on specified ports to enhance security and network performance.

Figure 86: Upstream Forwarding or Disabling Egress Flooding Example



In this example, the three ports are in an ISP-access VLAN. Ports 1 and 2 are connected to clients 1 and 2, respectively, and port 3 is an uplink to the ISP network. Because clients 1 and 2 are in the same VLAN, client 1 could possibly learn about the other client's traffic by sniffing client 2's broadcast traffic; client 1 could then possibly launch an attack on client 2.

However, when you disable all egress flooding on ports 1 and 2, this sort of attack is impossible, for the following reasons:

- Broadcast and multicast traffic from the clients is forwarded *only* to the uplink port.
- Any packet with unlearned destination MAC addresses is forwarded *only* to the uplink port.
- One client cannot learn any information from the other client. Because egress flooding is disabled on the access ports, the only packets forwarded to each access port are those packets that are specifically targeted for one of the ports. There is no traffic leakage.

In this way, the communication between client 1 and client 2 is controlled. If client 1 needs to communicate with client 2 and has that IP address, client 1 sends out an ARP request to resolve the IP address for client 2.

Guidelines for Enabling or Disabling Egress Flooding

The following guidelines apply to enabling and disabling egress flooding:

- Egress flooding can be disabled on ports that are in a load-sharing group. In a load-sharing group, the ports in the group take on the egress flooding state of the master port; each member port of the load-sharing group has the same state as the master port.
- FDB learning takes place on ingress ports and is independent of egress flooding; either can be enabled or disabled independently.
- Disabling unicast (or all) egress flooding to a port also prevents the flooding of packets with unknown MAC addresses *to* that port.
- Disabling broadcast (or all) egress flooding to a port also prevents the flooding of broadcast packets *to* that port.
- For BlackDiamond X-8 and 8800 series switches, SummitStack, and Summit family switches, the following guidelines apply:
 - You can enable or disable egress flooding for unicast, multicast, or broadcast MAC addresses, as well as for all packets on one or more ports.
 - Disabling multicasting egress flooding does not affect those packets within an IGMP membership group at all; those packets are still forwarded out.
 - If IGMP snooping is disabled, multicast packets with static FDB entries are forwarded according to the FDB entry.

Configuring Egress Flooding

To enable or disable egress flooding on BlackDiamond X-8 and 8800 series switches, SummitStack, and the Summit family switches, use the following commands:

```
enable flooding [all_cast | broadcast | multicast | unicast] ports [<port_list> | all]
disable flooding [all_cast | broadcast | multicast | unicast] ports [<port_list> | all]
```

Displaying Learning and Flooding Settings

To display the status of MAC learning and egress flooding, use the following commands:

```
show ports {mgmt | <port_list> | tag <tag>} information {detail}
```

```
show vlan {virtual-router <vr-name>}
```

```
show vman
```

The flags in the command display indicate the status.

Creating Blackhole FDB Entries

A blackhole FDB entry discards all packets addressed to or received from the specified MAC address. To create a blackhole FDB entry, use the following command:

```
create fdbentry <mac_addr> vlan <vlan_name> [ports <port_list> | blackhole]
```

There is no software indication or notification when packets are discarded because they match blackhole entries.

The `blackhole` option is also supported through access lists. For example, the following ACL policy would also blackhole traffic destined to or sourced from a specific MAC address:

```
entry blackhole_dest {
    if {
        ethernet-destination-address 00:00:00:00:00:01;
    } then {
        deny;
    }
}
entry blackhole_source {
    if {
        ethernet-source-address 00:00:00:00:00:01;
    } then {
        deny;
    }
}
```

A significant difference between the above ACL policy and the `create fdbentry` command `blackhole` option is the hardware used to implement the feature. Platforms with limited hardware ACL table sizes (for example, Summit X250e switches or BlackDiamond 8800 series switches) are able to implement this feature using the FDB table instead of an ACL table.

Managing MAC Address Tracking

The MAC address tracking feature tracks FDB add, move, and delete events for specified MAC addresses and for specified ports. When MAC address tracking is enabled for a port, this feature applies to all MAC addresses on the port.

When an event occurs for a specified address or port, the software generates an EMS message and can optionally send an SNMP trap. When MAC address tracking is enabled for a specific MAC address, this feature updates internal event counters for the address. You can use this feature with the Universal Port feature to configure the switch in response to MAC address change events (for an example, see [Chapter 6, “Universal Port”](#)).



NOTE

When a MAC address is configured in the tracking table, but detected on a MAC tracking enabled port, the per MAC address statistical counters are not updated.

The MAC address tracking feature is always enabled, however, you must configure MAC addresses or ports before tracking begins. The default configuration contains no MAC addresses in the MAC address tracking table and disables this feature on all ports.

The following sections describe how to manage this feature:

- [Adding and Deleting MAC Addresses for Tracking on page 605](#)
- [Enabling and Disabling MAC Address Tracking on Ports on page 605](#)
- [Enabling and Disabling SNMP Traps for MAC Address Changes on page 605](#)
- [Configuring Automatic Responses to MAC Tracking Events on page 605](#)
- [Displaying the Tracked MAC Addresses and Tracking Statistics on page 605](#)

- [Clearing the Tracking Statistics Counters on page 605](#)

Adding and Deleting MAC Addresses for Tracking

Use the following commands to add or delete MAC addresses in the MAC address tracking table:

```
create fdb mac-tracking entry <mac_addr>
delete fdb mac-tracking entry [<mac_addr> | all]
```

Enabling and Disabling MAC Address Tracking on Ports

Use the following command to enable or disable MAC addresses tracking on specific ports:

```
configure fdb mac-tracking {[add|delete]} ports [<port_list>|all]
```

Enabling and Disabling SNMP Traps for MAC Address Changes

The default switch configuration disables SNMP traps for MAC address changes. Use the following commands to enable or disable SNMP traps for MAC address tracking events:

```
enable snmp traps fdb mac-tracking
disable snmp traps fdb mac-tracking
```

Configuring Automatic Responses to MAC Tracking Events

The EMS messages produced by the MAC address tracking feature can be used to trigger Universal Port profiles as described in [“Event Management System Triggers” on page 333](#). The subcomponent name for MAC address tracking events is *FDB.MACTracking*.

Displaying the Tracked MAC Addresses and Tracking Statistics

Use the following command to display the MAC address tracking feature configuration, including the list of tracked MAC addresses:

```
show fdb mac-tracking configuration
```

Use the following command to display the counters for MAC address add, move, and delete events:

```
show fdb mac-tracking statistics {<mac_addr>} {no-refresh}
```

Clearing the Tracking Statistics Counters

There are several ways to clear the MAC tracking counters:

- Use the `clear counters` command
- Use the 0 key while displaying the counters with the `show fdb mac-tracking statistics {<mac_addr>} command`
- Enter the `clear counters fdb mac-tracking [<mac_addr> | all] command`

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CHAPTER

Data Center Solutions

This chapter includes the following sections:

- [Overview on page 607](#)
- [Introduction to Data Center Bridging on page 607](#)
- [Managing the DCBX Feature on page 616](#)
- [Introduction to the XNV Feature on page 614](#)
- [Managing the XNV Feature, VM Tracking on page 618](#)
- [Introduction to the Direct Attach Feature on page 616](#)
- [Managing Direct Attach to Support VEPA on page 635](#)
- [Introduction to FIP Snooping on page 636](#)
- [Managing the FIP Snooping Feature on page 635](#)

Overview

Typical data centers support multiple Virtual Machines (VMs) on a single server. These VMs usually require network connectivity to provide their services to network users and to other VMs. The following sections introduce ExtremeXOS software features that support VM network connectivity:



NOTE

For additional information on using ExtremeXOS features to implement Data Center Bridging, see the application note titled *Enhanced Transmission Selection (ETS) Deployment and Configuration for ExtremeXOS* on the Extreme Networks web site, www.extremenetworks.com.

Introduction to Data Center Bridging

Data Center Bridging (DCB) is a set of IEEE 802.1Q extensions to standard Ethernet, that provide an operational framework for unifying Local Area Networks (LAN), Storage Area Networks (SAN) and Inter-Process Communication (IPC) traffic between switches and endpoints onto a single transport layer. The following sections provide information on DCBX features:

- [Data Center Bridging Exchange Protocol on page 608](#)
- [Custom Application Support on page 608](#)

- [Enhanced Transmission Selection on page 609](#)
- [Priority-based Flow Control on page 613](#)

Data Center Bridging Exchange Protocol

The Data Center Bridging eXchange (DCBX) protocol is used by Data Center Bridging (DCB) devices to exchange DCB configuration information with directly connected peers. In an ExtremeXOS enabled switch, the switch uses DCBX to advertise its DCB configuration to end stations. The end stations can then configure themselves to use the switch DCB services. If the peers do not support a common configuration for one or more features, the switch generates messages to alert network management. The switch does not accept configuration change requests from end stations.

The DCBX protocol advertises the following types of information:

- DCBX version information, so that the peers can negotiate a common version to use.
- Enhanced Transmission Selection (ETS) information for QoS parameters such as bandwidth allocation per traffic class (802.1p COS), priority for each traffic class, and the algorithm used for servicing traffic classes.
- Priority-based Flow Control (PFC) information for managing flow control between peers.
- Application priority information for prioritizing traffic for special applications that do not map directly to an established traffic class.

The ExtremeXOS software supports two versions of DCBX standards. The first version is a pre-standard version known as the *baseline version*, or more specifically as *Baseline Version 1.01*. The DCBX baseline version is specified in *DCB Capability Exchange Protocol Base Specification Rev 1.01* and was developed outside of the IEEE and later submitted to the IEEE for standardization. The IEEE agreed to standardize DCBX as part of *IEEE 802.1Qaz Enhanced Transmission Selection for Bandwidth Sharing Between Traffic Classes*. While IEEE 802.1Qaz has progressed through the standards process, many companies have released support for the baseline version. IEEE 802.1Qaz is nearing completion, and support is expected to start rolling out during 2011.

After you enable DCBX, the protocol collects most of the information to be advertised from other switch services such as QoS and PFC. The only DCBX feature that needs configuration is the application priority feature.

DCBX uses the Link Layer Discovery Protocol (LLDP) (IEEE 802.1AB) to exchange attributes between two link peers. DCBX attributes are packaged into organizationally specific TLVs, which are different for the Baseline and IEEE 802.1Qaz versions. Information on the TLV support differences is provided in the *ExtremeXOS Command Reference* under the command description for the `show lldp {port [all | <port_list>]} dcbx {ieee|baseline} {detailed}` command.

Custom Application Support

The DCBX custom application support feature allows you to prioritize and manage traffic flow through the switch based on the application type. This feature allows you to configure DCBX handling of the following applications:

- Fiber Channel Over Ethernet (FCoE)
- FCoE Initiation Protocol (FIP)
- Internet Small Computer System Interface (iSCSI)
- Any application that can be defined by:
 - Ethertype value

- Layer 4 port number
- TCP port number
- UDP port number

When you configure a custom application, you define a priority number that applies to traffic related to that application. DCBX advertises this priority to end stations in an application TLV. End stations that support this feature use the priority number for communications with the switch. The priority number maps to an 802.1p value, which determines which QoS profile in the switch manages the application traffic.

The software supports a maximum of 8 application configurations.

Enhanced Transmission Selection

Enhanced Transmission Selection is defined in IEEE P802.1Qaz/D2.3, *Virtual Bridged Local Area Networks-Amendment XX: Enhanced Transmission Selection for Bandwidth Sharing Between Traffic Classes*. This IEEE 802.1Qaz standard also defines one of the DCBX versions supported by the ExtremeXOS software.

ETS, and similar features in the Baseline DCBX standard, define methods for managing bandwidth allocation among traffic classes (called Priority Groups (PGs) in Baseline DCBX) and mapping 802.1p COS traffic to those traffic classes.

The rest of this section provides general guidelines for configuring the ExtremeXOS QoS feature to conform to the ETS requirements. After you configure QoS, DCBX advertises the ETS compatible configuration to DCBX peers on all DCBX enabled ports.

ETS configuration is affected by the following set of QoS objects:

- QoS scheduler
- QoS profile
- dot1p

By default, the scheduling is set to *strict-priority*. The following command enables ETS compatible (weighted) scheduling:

```
configure qosscheduler [strict-priority | weighted-round-robin | weighted-deficit-round-robin]
```

Each QoS profile supports an IEEE ETS traffic class (TC) or a Baseline DCBX priority group (PG). To determine which QoS profile serves a TC or PG, add the number 1 to the TC or PG number. For example, TC 0 and PG 0 are served by QoS profile 1. ExtremeXOS switches support up to eight QoS profiles and can therefore support up to eight TCs or PGs. The following QoS configuration changes affect the ETS/PG configuration:

- QoS profile:
 - When you create or delete a QoS profile, you add or remove support for the corresponding TC or PG.
 - The weight configuration helps determine the bandwidth for a TC or PG.
 - The use-strict-priority configuration overrides ETS scheduling and selects strict priority scheduling for the corresponding TC or PG.

- The dot1p configuration maps each 802.1p priority, and the associated TC and PG, to a QoS profile. If you change the 802.1p mapping, it will change which QoS profile services each TC or PG.
- Per port configuration parameters:
 - minbw: Sets a minimum guaranteed bandwidth in percent.
 - maxbw: Sets a maximum guaranteed bandwidth in percent.
 - committed_rate: Sets a minimum guaranteed bandwidth in Kbps or Mbps.
 - peak_rate: Sets a maximum guaranteed bandwidth in Kbps or Mbps.

For example, the following set of commands creates a QoS profile (qp5) in preparation to support iSCSI traffic, maps packets with 802.1p priority 4 to QoS profile 5, indicates that QoS profile 8 should use strict priority, and sets the weight for the ETS classes:

```
create qosprofile qp5
configure dot1p type 4 qosprofile qp5
configure qosprofile qp1 weight 1
configure qosprofile qp5 weight 2
configure qosprofile qp8 use-strict-priority
```

**NOTE**

All Extreme Networks DCB-capable switches are configured with qp1 and qp8 by default, and some platforms support additional QoS profiles by default. When stacking is used for Summit switches, qp7 is created by default for internal control communications, and is always set to strict priority.

DCBX only advertises the bandwidth for ETS classes, so in the example, the available bandwidth is divided only between qp1 and qp5. The total bandwidth for all ETS classes must add up to 100%, so if the weights don't divide evenly, one or more of the reported bandwidth numbers are rounded to satisfy this requirement. With this in mind, the above configuration results in reported bandwidth guarantees of 33% for TC/PG 0 (qp1) and 67% for TC/PG 4 (qp5).

Weighted round robin scheduling is packet based, so when packets are queued for both classes 0 and 4, the above configuration results in two TC/PG 4 packets being transmitted for each single TC/PG 0 packet. As such, the exact percentages are realized only when the average packet sizes for both classes are the same and the measurement is taken over a long enough period of time. Another consideration is that using the lowest weights possible to achieve the desired ratios results in a more even distribution of packets within a class (that is, less jitter). For example, using weights 1 and 2 are usually preferable to using weights 5 and 10—even though the resulting bandwidth percentages are the same.

Enhanced Transmission Selection allows you to configure QoS scheduling to be weighted-deficit-round-robin. In this approach, you can configure a weight in the range of 1–127 on the QoS profiles. The difference between weighted-round-robin (WRR) and weighted-deficit-round-robin (WDRR) is that, in the latter approach, the algorithm uses a “credit counter” mechanism.

The algorithm works in slightly different ways on different platforms:

Platform: Summit X650, X480, X460, X440 series switches; BlackDiamond 8800 series switches with 8900-G96T-c, 8900-10G24X-c, 8900-MSM128, 8900-G48T-xl, 8900-G48X-xl, and 8900-10G8X-xl modules; E4G-400, E4G-200 cell site routers.

Methodology:

- Credit counter—A token bucket that keeps track of bandwidth overuse relative to each queue's specified weight.
- Weight—Relative bandwidth allocation to be serviced from a queue in each round compared with other queues. Range is between 1 and 127. A weight of 1 equals a unit of 128 bytes.
- MTU Quantum Value—2 Kbytes
 - a Set credit counter to quantum value for all queues.
 - b Service queues in round robin order, according to the weight value. When a packet from a queue is sent, the size of the packet is subtracted from the credit counter. A queue is serviced until it is either empty or its credit counter is negative.
 - c When all queues are either empty or their credit counter is less than 0, replenish credits by: MTU quantum value x weight of queue. No queue's credit can ever be more than quantum value x weight.
 - d Repeat steps b and c until all queues are empty.

Platform: Summit X670 series switches; BlackDiamond 8800 series switches with 8900-40G6X-xm module; BlackDiamond X8 series switches with BDX-MM1, BDXA-FM960, BDXA-FM480, BDXA-40G24X, and BDXA-40G12X modules.

Methodology:

- Credit counter—A token bucket used to keep track of bandwidth overuse relative to each queue's specified weight.
- Weight—Relative bandwidth allocation to be serviced from a queue in each round compared with other queues. Range is between 1 and 127.
- K—Minimum value required to make all credit counters positive. This value is recalculated after each round.
 - a Set credit counter for each queue to queue's weight value.
 - b Service queues in round robin order, according to the weight value. When a packet from a queue is sent, the size of the packet is subtracted from the credit counter. A queue is serviced until it is either empty or its credit counter is negative.
 - c When all queues are either empty or their credit counter is less than 0, replenish credits by: $2^K \times$ weight of queue. K is calculated so that it is the minimum value required to make all credit counters positive. No queue's credit can ever be more than $2^K \times$ weight of queue.
 - d Repeat steps b and c until all queues are empty.

Platform: Summit X250e, X450e, X450a series switches; BlackDiamond 8800 series switches with G48Te, G48Te2, G24Xc, G48Xc, G48Tc, 10G4Xc, 10G8Xc, MSM-48, S-G8Xc, S-10G1Xc, 8500-G24X-e, 8500-G48T-e, and S-10G2Xc modules.

Methodology: These cards have a weight range of 1 to 15. Credit is replenished by $2^{(\text{weight} - 1)} \times 10\text{KB}$. The number of bytes that can be transmitted in a single round is:

- Weight 0 = Strict Priority
- Weight 1 = 10 KB
- Weight 2 = 20 KB
- Weight 3 = 40 KB
- Weight 4 = 80 KB

- Weight 5 = 160 KB
- Weight 6 = 320 KB
- Weight 7 = 640 KB
- Weight 8 = 1,280 KB
- Weight 9 = 2,560 KB
- Weight 10 = 5,120 KB
- Weight 11 = 10 MB
- Weight 12 = 20 MB
- Weight 13 = 40 MB
- Weight 14 = 80 MB
- Weight 15 = 160 MB

When ETS scheduling is used without a `minbw` or `committed_rate` configured, packets from strict priority classes always preempt packets from ETS classes, so the reported percentages reflect the distribution of the bandwidth after strict priority classes use what they need. Because of this, one might consider limiting the bandwidth for any strict priority classes using the `maxbw` parameter. For example, the following command limits TC/PG 7 to 20% of the interface bandwidth:

```
configure qosprofile qp8 maxbw 20 ports 1-24
```

The per-port bandwidth settings described above can also be used to either limit or guarantee bandwidth for an ETS class. For example, the following command guarantees 40% of the bandwidth to TC/PG 0:

```
configure qosprofile qp1 minbw 40 ports 1-24
```

The DCBX protocol takes these minimum and maximum bandwidth guarantees into account when calculating the reported bandwidth. With the addition of this minimum bandwidth configuration, the reported bandwidth would change to 40% for class 0 (qp1) and 60% for class 4 (qp5).

The following are some important considerations when using minimum and maximum bandwidth guarantees:

- They change the scheduling dynamic such that a class with a `minbw` will have priority over other classes (including strict priority classes) until the `minbw` is met, which differs from the standard ETS scheduling behavior described in 802.1az
- If the `minbw` is set on multiple classes such that the total is 100%, these classes can starve other classes that do not have a configured `minbw`. So, for example, if the `minbw` for both class 0 and class 4 is set to 50% (100% total), traffic from these classes can starve class 7 traffic. This can lead to undesirable results since DCBX and other protocols are transmitted on class 7. In particular, DCBX may report the peer TLV as expired. This effect can be magnified when an egress port shaper is used to limit the egress bandwidth.
- If all ETS classes have a `maxbw` set, and the total is less than 100%, the total bandwidth reported by DCBX will be less than 100%. Extreme does not report an error in this case, but some DCBX peers may report an error.
- Packet size is a factor in the minimum and maximum bandwidth guarantees.

In light of these considerations, the following are a set of guidelines for using minimum and maximum bandwidth guarantees:

- If `minbw` guarantees are used for ETS classes, and strict priority classes exist
 - Make sure that the total `minbw` reserved is less than 100%.

- Also configure minbw for the strict priority classes.
- If strict priority classes exist, you may want to configure a maxbw for the strict priority classes so they don't starve the ETS classes.
- If maxbw is configured on some ETS classes, ensure that either the total of the maxbw settings for all ETS classes is equal to 100%, or at least one ETS class does not have a maxbw configured.

For more information on the QoS features that support ETS, see [Chapter 20, “QoS.”](#)

Priority-based Flow Control

Priority flow control (PFC) is defined in the IEEE 802.1Qbb standard as an extension of the IEEE 802.3x flow control standard. When buffer congestion is detected, IEEE 802.3x flow control allows the communicating device to pause all traffic on the port, whereas PFC allows the device to pause just a portion of the traffic and allow other traffic on the same port to continue.

The rest of this section provides general guidelines for configuring the ExtremeXOS PFC feature for DCBX operation. After you configure PFC, DCBX advertises the PFC compatible configuration to DCBX peers on all DCBX enabled ports.

PFC configuration is controlled per-port using the following command:

```
enable flow-control [tx-pause {priority <priority>} | rx-pause {qosprofile
<qosprofile>}] ports [all | <port_list>]
```

The `rx-pause` option is configured on the QoS profile. The PFC priority to which a QoS profile responds is fixed and is determined by the QoS profile number such that qpN responds to a PFC frame for priority N-1. For example, the following command enables PFC priority 4 for qp5 on ports 1-24:

```
enable flow-control rx-pause qosprofile qp5 ports 1-24
```

After the above command is entered, if a PFC frame is received indicating that priority 4 should be paused, then qp5 will be paused. Note that qp5 is paused regardless of whether the packets mapped to qp5 have priority 4 or other priorities. For example, if we enter the command `configure dot1p type 3 qosprofile qp5`, priority 3 packets are queued in qp5, and a PFC pause frame for priority 4 pauses priority 3 frames, which might not be desired. For this reason, you should be careful about mapping multiple priorities to the same QoS profile when PFC is enabled for that profile.

The `tx-pause` option is configured on the priority itself. For example, the following command enables the transmittal of PFC frames for priority 4 when frames with priority 4 are congested:

```
enable flow-control tx-pause priority 4 ports 1-24
```

The `tx-pause` configuration determines what is advertised in the DCBX PFC TLV. In order for PFC to work correctly, it is important to ensure that all switches in the DCB network are receiving and transmitting PFC consistently for each priority on all ports.

In summary, the following three commands ensure that PFC is enabled for priority 4 traffic on ports 1-24:

```
configure dot1p type 4 qosprofile qp5
enable flow-control rx-pause qosprofile qp5 ports 1-24
enable flow-control tx-pause priority 4 ports 1-24
```

For more information on PFC, see [“IEEE 802.1Qbb Priority Flow Control—BlackDiamond X8 Series Switches, BlackDiamond 8900-10G24X-c and 8900-40G6X-xm Modules and Summit X460, X650, and X670 Switches”](#) on page 225.

Introduction to the XNV Feature

The Extreme Network Virtualization (XNV) feature, which is also known as Virtual Machine (VM) tracking, enables the ExtremeXOS software to support VM port movement, port configuration, and inventory on network switches. VM movement and operation on one or more VM servers is managed by a VM Manager (VMM) application. The XNV feature enables a network switch to respond to VM movement and report VM activity to network management software.

VM network access support enables a switch to support VMs as follows:

- Identify a VM by its MAC address and authenticate the VM connection to the network
- Apply a custom port configuration in response to VM authentication
- Remove a custom port configuration when a VM FDB entry ages out
- Detect a VM move between switch ports or switches and configure the old and new ports appropriately

To support VM mobility, the XNV feature requires that each VM use unique, static MAC and IP addresses. Switch port operation for a VM can be configured with a policy file or an ACL.

The following sections provide more information on the XNV feature:

- [VM Port Configuration on page 614](#)
- [VM Authentication Process on page 614](#)
- [File Synchronization on page 616](#)
- [Network Management and Inventory on page 616](#)

VM Port Configuration

An important part of the XNV feature is the ability to configure a switch port to support a particular VM. A Virtual Port Profile (VPP) identifies a policy file or ACL rule to associate with a VM entry in the authentication database. You can define both ingress and egress policies in VPPs to configure a port separately for each direction. When the VPP is configured for a VM entry and the VM is detected on a port, any associated policy or rule is applied to the port in the specified direction.

The XNV feature supports two types of VPPs, Network VPPs (NVPPs) and Local VPPs (LVPPs).

NVPPs are stored on an FTP server called a *repository server*. The XNV feature supports file synchronization between XNV-enabled switches and the repository server. One of the advantages of the repository server is centralized storage for NVPPs.

LVPPs must be configured on each switch. LVPPs are a good choice for simple network topologies, but NVPPs offer easier network management for more complex network topologies.

VM Authentication Process

The XNV feature supports three methods of authentication:

- NMS server authentication.
- Network authentication using a downloaded authentication database stored in the VMMAP file.
- Local authentication using a local database created with ExtremeXOS CLI commands.

The default VM authentication configuration uses all three methods in the following sequence: NMS server (first choice), network based VMMAP file (second choice), and finally, local database. If a service is not available, the switch tries the next authentication service in the sequence.

The following sections describe authentication process options:

- [NMS Server Authentication on page 615](#)
- [Network \(VMMAP\) Authentication on page 615](#)
- [Local Authentication on page 615](#)

NMS Server Authentication. If NMS server authentication is enabled and a VM MAC address is detected on a VM-tracking enabled port, the software sends an Access-Request to the configured NMS server for authentication. When the switch receives a response, the switch does one of the following:

- When an Access-Accept packet is received with an NVPP specified, the policies are applied on VM enabled port.
- When an Access-Accept packet is received and no NVPP is specified, the port is authenticated and no policy is applied to the port.
- When an Access-Reject packet is received, the port is unauthenticated and no policy is applied.
- When an Access-Reject packet indicates that the NMS server timed-out or is not reachable, the switch tries to authenticate the VM MAC address based on the next authentication method configured, which can be either network authentication or local authentication.

The Access-Accept packet from the NMS server can include the following Vendor Specific Attributes (VSAs):

- VM name
- VM IP address
- VPP configured for the VM

An Access-Reject packet contains no VSA.

Network (VMMAP) Authentication. If network (VMMAP) authentication is enabled and a VM MAC address is detected on a VM-tracking enabled port, the switch uses the VMMAP file to authenticate the VM and applies the appropriate VPP.

Local Authentication. If local authentication is enabled and a VM MAC address is detected on a VM-tracking enabled port, the switch uses the local database to authenticate the VM and apply the appropriate VPP.

Authentication Failure. If all configured authentication methods fail, EMS messages are logged and no VPP is applied. Possible remedies include:

- Fix the authentication process that failed. Look for misconfiguration or down segments.
- Configure UPM to take action on the related EMS message.
- If one or two authentication methods are configured, configure additional authentication methods.

Duplicate VM MAC Detected. Each VM MAC must be unique. If duplicate MAC addresses are detected on the switch, whether on the same VLAN or different VLANs, the switch supports only the last MAC detected.

File Synchronization

The XNV feature supports file synchronization between XNV-enabled switches and the repository server. The files stored on the repository server include the .map, .vpp, and .pol files. One of the advantages of the repository server is that multiple XNV-enabled switches can use the repository server to collect the network VM configuration files. The XNV feature provides for access to a *secondary* repository server if the *primary* repository server is unavailable.

Through file synchronization, the network files are periodically downloaded to the XNV-enabled switches, which allows these switches to continue to support VM authentication when the NMS server is unavailable.

Network Management and Inventory

The XNV feature is designed to support network management programs such as Ridgeline. The ExtremeXOS software contains SNMP MIBs, which allow network management programs to view VM network configuration data, discover the VM inventory, and make configuration changes. Ridgeline is enhanced to interface with VMMs and perform most VM network configuration tasks. Extreme Networks recommends that you use Ridgeline to manage VM network connectivity.

For instructions on managing the XNV feature using the switch CLI, see [“Managing the XNV Feature, VM Tracking” on page 618](#).

Introduction to the Direct Attach Feature

The direct attach feature is a port configuration feature that supports VM-to-VM communication on a directly connected server that uses the Virtual Ethernet Port Aggregator (VEPA) feature on that server. Without VEPA and direct attach, a VM server must use a virtual Ethernet bridge or switch on the VM server to enable Ethernet communications between VMs. With VEPA, the VM server can rely on a directly connected switch to receive and *reflect* VM-to-VM messages between VMs on the same server.

The ExtremeXOS direct attach feature works with VEPA software on a VM server to intelligently forward unicast, flood, and broadcast traffic. Without direct attach, frames are never forwarded back out the same port on which they arrive. With direct attach, frames can be forwarded back out the ingress port, and VEPA software on the VM server ensures that the frames are forwarded appropriately.

For instructions on managing the Direct Attach feature, see [“Managing Direct Attach to Support VEPA” on page 635](#).

Managing the DCBX Feature

This section provides the following DCBX feature topics:

- [Enabling DCBX on Switch Ports on page 617](#)
- [Configuring DCBX Application Priority Instances on page 617](#)
- [Displaying DCBX Configuration and Statistics on page 617](#)
- [DCBX Configuration Example on page 617](#)

Enabling DCBX on Switch Ports

DCBX uses LLDP to advertise DCB capabilities to DCB peers. Use the following commands to enable LLDP and the DCBX feature on switch ports:

```
enable lldp ports [all | <port_list>] {receive-only | transmit-only}

configure lldp ports [all | <port_list>] [advertise | no-advertise] vendor-specific
dcbx {ieee|baseline}
```

Configuring DCBX Application Priority Instances

Each DCBX application priority instance maps traffic from one of the supported application types to a TC or PG priority, which selects a specific QoS profile for traffic management. Supported application types include:

- Fiber Channel Over Ethernet (FCoE)
- FCoE Initiation Protocol (FIP)
- Internet Small Computer System Interface (iSCSI)

Use the following commands to add or delete DCBX application priority instances:

```
configure lldp ports [all | <port_list>] dcbx add application [name <application_name>
| ethertype <ethertype_value> | L4-port <port_number> | tcp-port <port_number> | udp-
port <port_number>] priority <priority_value>

configure lldp ports [all | <port_list>] dcbx delete application [all-applications |
name <application_name> | ethertype <ethertype_value> | L4-port <port_number> | tcp-
port <port_number> | udp-port <port_number>]
```

Displaying DCBX Configuration and Statistics

Use the following commands to display DCBX feature configuration and statistics:

```
show lldp {port [all | <port_list>]} {detailed}

show lldp {port [all | <port_list>]} dcbx {ieee|baseline} {detailed}
```

DCBX Configuration Example

The following is a sample DCBX configuration:

```
enable lldp ports 1
configure lldp port 1 advertise vendor-specific dcbx ieee
configure lldp port 1 advertise vendor-specific dcbx baseline

enable lldp ports 2
configure lldp port 2 advertise vendor-specific dcbx ieee
configure lldp port 2 advertise vendor-specific dcbx baseline

configure lldp ports 1 dcbx add application name iscsi priority 4
configure lldp ports 1 dcbx add application name fcoe priority 3
configure lldp ports 1 dcbx add application name fip priority 3
```

```
configure lldp ports 2 dcbx add application name iscsi priority 4
configure lldp ports 2 dcbx add application name fcoe priority 3
configure lldp ports 2 dcbx add application name fip priority 3
configure lldp ports 2 dcbx add application L4-port 25 priority 4
configure lldp ports 2 dcbx add application tcp-port 4500 priority 4
configure lldp ports 2 dcbx add application udp-port 45 priority 5
configure lldp ports 2 dcbx add application ethertype 2536 priority 4
```

Managing the XNV Feature, VM Tracking

The following sections describe how to manage the XNV feature:

- [Limitations on page 618](#)
- [Managing VM Tracking on the Switch on page 618](#)
- [Managing VM Tracking on Specific Ports on page 619](#)
- [Configuring the Authentication Method and Sequence on page 619](#)
- [Managing the Repository Server on page 619](#)
- [Managing NMS Server Authentication on page 623](#)
- [Managing Network Authentication \(Using the VM MAP File\) on page 624](#)
- [Managing Local Database Authentication on page 624](#)
- [Example XNV Configuration on page 625](#)

Limitations

The following limitations apply to this release of the VM tracking feature:

- When VM tracking is configured on a port, all existing learned MAC addresses are flushed. MAC addresses will be relearned by the switch and the appropriate VPP (if any) for each VM will be applied.
- If a VM changes MAC addresses while moving between ports on a switch, the VM remains authenticated on the original port until the original MAC address ages out of the FDB.
- VM counters are cleared when a VM moves between ports on the same switch (because the ACLs are deleted and recreated).
- Each VPP entry supports a maximum of 8 ingress and 4 egress ACL or policies.
- For Network VPP only policy files can be mapped. For Local VPP either ACL or policy files can be mapped. You cannot map a mixture of both ACL and policy files to a particular VPP.

Managing VM Tracking on the Switch

You must enable the VM tracking feature before you can configure it. To enable the VM tracking feature on the switch, use the following command:

```
enable vm-tracking
```

To disable the VM tracking feature on the switch, use following command:

```
disable vm-tracking
```

**NOTE**

When the VM tracking feature is disabled, file synchronization with the repository server stops.

To view the VM tracking feature configuration and the list of authenticated VMs, use the following command:

```
show vm-tracking
```

Managing VM Tracking on Specific Ports

Before you enable the VM tracking feature on specific ports, you must enable VM tracking on the switch, configure the authentication method and sequence, and the VM authentication databases. When this configuration is complete, you can use the following command to enable VM tracking on one or more ports:

```
enable vm-tracking ports <port_list>
```

To disable the VM tracking feature on a group of ports, use following command:

```
disable vm-tracking ports <port_list>
```

To view the VM tracking feature configuration on one or more ports, use the following command:

```
show vm-tracking port <port_list>
```

Configuring the Authentication Method and Sequence

You can configure VM authentication through the following services:

- NMS server
- Network based VMMAP file
- Local database

The default VM authentication configuration uses all three methods in the following sequence: NMS server (first choice), network based VMMAP file (second choice), and finally, local database. If a service is not available, the switch tries the next authentication service in the sequence.

To configure one or more authentication methods and a preferred sequence, use the following command:

```
configure vm-tracking authentication database-order [[nms] | [vm-map] | [local] | [nms local] | [local nms] | [nms vm-map] | [vm-map local] | [local vm-map] | [nms vm-map local] | [local nms vm-map]]
```

Managing the Repository Server

The following sections describe how to manage the repository server:

- [Selecting the Repository Server Directory on page 620](#)
- [Creating the MANIFEST File on page 620](#)
- [Creating a VMMAP File on page 621](#)

- [Creating VPP Files on page 621](#)
- [Creating Policy Files on page 622](#)
- [Managing Switch Access to the Repository Server on page 622](#)

Selecting the Repository Server Directory

All files for NMS and network authentication must be placed in the configured repository server directory. These files include the following:

- MANIFEST
- VM MAP
- NVPP policy files

By default, the XNV feature tries to access the FTP server with anonymous login and fetch the files from the `pub` directory within the FTP server root directory. To configure a different directory for repository server files, use the following command:

```
configure vm-tracking repository
```

Creating the MANIFEST File

The MANIFEST file identifies the VM MAP, NVPP, and policy files that are to be used for either NMS or network authentication. The MANIFEST file is downloaded to the switch at the specified refresh interval. Each time the MANIFEST file is downloaded, the switch scans the file and compares the file entries and timestamps to those files on the switch. If the switch detects newer files, it downloads those files to the switch.

You can create the MANIFEST file with a text editor. The MANIFEST file must be placed on the repository server as described in [“Selecting the Repository Server Directory” on page 620](#).

The format of MANIFEST files is:

```
File1 yyyy-mm-dd hh:mm:ss  
File2 yyyy-mm-dd hh:mm:ss
```

Because the definition for each file in the MANIFEST includes a date and time, you must update the MANIFEST file every time you update the VM MAP file or a policy file.

The following is a sample MANIFEST file:

```
a1.map 2010-07-07 18:57:00  
a1.vpp 2010-07-07 18:57:00  
a2.map 2010-07-07 18:57:00  
a2.vpp 2010-07-07 18:57:00  
policy1.pol 2010-07-07 18:57:00  
epolicy1.pol 2010-07-07 18:57:00
```

The file extensions for the files in the MANIFEST file identify the supported file types:

- `.map`—VM MAP files
- `.vpp`—VPP files
- `.pol`—Policy files

Creating a VMMAP File

Use a text editor to create a VMMAP file. VMMAP file entries must use the following XML format:

```
<VMLIST>
  <VM>
    <MAC>00:00:00:00:00:21</MAC>
    <NAME>network_vm1</NAME>
    <IPV4>10.10.10.10</IPV4>
    <VPP>nvpp1</VPP>
  </VM>
  <VM>
    <MAC>00:00:00:00:00:22</MAC>
    <NAME>network_vm2</NAME>
    <IPV4>20.20.20.20</IPV4>
    <VPP>nvpp2</VPP>
  </VM>
</VMLIST>
```



NOTE

In a future release of Ridgeline, you will be able to use Ridgeline to export the NMS VM authentication entries to a VMMAP file on a repository server for VM authentication when the NMS server is unavailable. Instructions for this will be provided in the Ridgeline documentation.

When creating VMMAP file entries, use the following guidelines:

- The VPP file supports up to 400 child nodes
- The MAC address is required.
- If you do not want to specify a VM name, specify `none`.
- If you do not want to specify an IP address, specify `0.0.0.0`.
- If you do not want to specify a VPP name, specify `none`.
- If a value such as the VM name contains any space characters, the entire value must be specified between double quotation marks.

For information on where to place the VMMAP file, see [“Selecting the Repository Server Directory”](#) on page 620.

Creating VPP Files

Use a text editor to create a VPP file. VPP file entries must use the following XML format:

```
<vppList>
  <vpp>
    <name>nvpp1</name>
    <last-updated>2002-05-30T09:00:00</last-updated>
    <policy>
      <name>policy1</name>
      <direction>ingress</direction>
      <order>1</order>
    </policy>
  </vpp>
</vppList>
```

```

<policy>
  <name>policy4</name>
  <direction>ingress</direction>
  <order>4</order>
</policy>
<policy>
  <name>epolicy1</name>
  <direction>egress</direction>
  <order>1</order>
</policy>
<policy>
  <name>epolicy4</name>
  <direction>egress</direction>
  <order>4</order>
</policy>
</vpp>
</vppList>

```

The VPP file supports up to 400 child nodes, and each VPP entry supports up to 8 ingress and 4 egress ACL or policies. If multiple policies are defined within a VPP entry for either ingress or egress, the switch uses the policy with the lowest order number. If two ingress or egress policies have the same order number, the switch selects the policy based on which name is lexicographically lower.

To refresh all policies which are all associated and applied to each VPP, use the following command:

```
refresh policy <policy-name>
```

The NVPP policy files must be placed on the repository server as described in [“Selecting the Repository Server Directory”](#) on page 620.

Creating Policy Files

For instructions on creating policy files, see [Chapter 17, “Policy Manager.”](#)



NOTE

In a future release of Ridgeline, you will be able to use Ridgeline to export the policy files to a repository server for VM port configuration when the NMS server is unavailable. Instructions for this will be provided in the Ridgeline documentation.

To display the policy file or ACL associated with one or all VPPs, use the following command:

```
show vm-tracking vpp {<vpp_name>}
```

Managing Switch Access to the Repository Server

To enable and configure file synchronization between an XNV-enabled switch and a repository server, use the following command:

```
configure vm-tracking repository [primary | secondary] server [<ipaddress> |
<hostname>] {vr <vr-name>} {refresh-interval <seconds>} {path-name <path_name>} {user
<user_name> {encrypted} <password>}
```

To force file synchronization with the repository server, use the following command:

```
run vm-tracking repository sync-now
```

To remove the configuration for one or both repository servers, use the following command:

```
unconfigure vm-tracking repository {primary | secondary}
```

To display the repository server configuration and status, use the following command:

```
show vm-tracking repository {primary | secondary}
```

Managing NMS Server Authentication

NMS server authentication uses the RADIUS protocol to authenticate VM access to the network with the RADIUS server included with Ridgeline. Ridgeline is designed to perform VM network management tasks, such as creating and associating NVPPs with VM authentication entries.

To use NMS authentication, you must do the following:

- Select NMS authentication as described in [“Configuring the Authentication Method and Sequence” on page 619](#).
- Prepare the network repository server as described in [“Managing the Repository Server” on page 619](#).
- Configure the NMS client software in the switch as described in [“Configuring the NMS Client Software” on page 624](#).
- Configure the NMS server as described in [“Configuring the NMS Server Software” on page 623](#).

You can display NMS authenticated VMs as described in [“Displaying NMS Authenticated VMs” on page 624](#).

Configuring the NMS Server Software

The Ridgeline product includes a RADIUS server that you can use for NMS server authentication. To configure this server, do the following:

- 1 Add the IP address of each XNV-enabled switch as a RADIUS client.
- 2 Add each VM MAC address as a username (in upper case and should not contain semicolon) and add the MAC address as the password.
- 3 Add a remote access policy with the Extreme Networks VSAs:
 - Vendor code: 1916
 - VSA ID: 213 (EXTREME_VM_NAME)
Example: MyVM1
 - VSA ID: 214 (EXTREME_VM_VPP_NAME)
Example: nvpp1
 - VSA ID: 215 (EXTREME_VM_IP_ADDR)
Example: 11.1.1.254

For instructions on configuring the Ridgeline RADIUS server, refer to the Ridgeline documentation.

Configuring the NMS Client Software

The switch uses NMS client software to connect to an NMS server for VM authentication. Use the following commands to configure the NMS client software in the switch:

```
configure vm-tracking nms [primary | secondary] server [<ipaddress> | <hostname>]
{<udp_port>} client-ip <client_ip> shared-secret {encrypted} <secret> {vr <vr-name>}
```

```
configure vm-tracking nms timeout <seconds>
```

```
configure vm-tracking timers reauth-period <reauth_period>
```

To remove the NMS client configuration for one or both NMS servers, use the following command:

```
unconfigure vm-tracking nms {server [primary | secondary]}
```

To display the NMS client configuration, use the following command:

```
show vm-tracking nms server {primary | secondary}
```

Displaying NMS Authenticated VMs

To display the VMs and corresponding policies in the NMS authentication database, use the following command:

```
show vm-tracking network-vm
```

Managing Network Authentication (Using the VMMAP File)

To use network authentication, you must do the following:

- Select network authentication as described in “[Configuring the Authentication Method and Sequence](#)” on page 619.
- Prepare the network repository server as described in “[Managing the Repository Server](#)” on page 619.

To display the VMs and corresponding policies in the network authentication database, use the following command:

```
show vm-tracking network-vm
```

Managing Local Database Authentication

To use local database authentication, you must do the following:

- Select local database authentication as described in “[Configuring the Authentication Method and Sequence](#)” on page 619.
- Create and manage local VPPs (LVPPs) as described in “[Managing the Local VPP Database](#)” on page 625.
- Create VM entries as described in “[Managing VM Entries in the Local Authentication Database](#)” on page 625.

Managing the Local VPP Database

Only one dynamic ACL or policy can be added to a VPP. Ingress LVPPs apply to traffic flowing from the VM, into the switch port, and then to the client. Egress LVPPs apply to traffic flowing from the client, out the switch port, and to the VM.

For instructions on creating policy files, see [Chapter 17, “Policy Manager.”](#) For instructions on creating dynamic ACLs, see [Chapter 18, “ACLs.”](#)

To create and configure entries in the LVPP database, use the following commands:

```
create vm-tracking vpp <vpp_name>
configure vm-tracking vpp <vpp_name> add [ingress | egress] [policy <policy_name> |
dynamic-rule <rule_name>] {policy-order <policy_order>}
```

To delete or unconfigure entries in the local VPP database, use the following commands:

```
delete vm-tracking vpp {<vpp_name>}
unconfigure vm-tracking vpp <vpp_name>
```

To display the policy file or ACL associated with one or more VPPs, use the following command:

```
show vm-tracking vpp {<vpp_name>}
```

Managing VM Entries in the Local Authentication Database

To create and configure entries in the local authentication database, use the following commands:

```
create vm-tracking local-vm mac-address <mac> {name <name> | ip-address <ipaddress> |
vpp <vpp_name>}
configure vm-tracking local-vm mac-address <mac> [name <name> | ip-address <ipaddress>
| vpp <vpp_name>]
```

To remove a configuration parameter for a local authentication database entry, or to remove an entry, use the following commands:

```
unconfigure vm-tracking local-vm mac-address <mac> [name | ip-address | vpp]
delete vm-tracking local-vm {mac-address <mac>}
```

To display the local VPP database entries, use the following command:

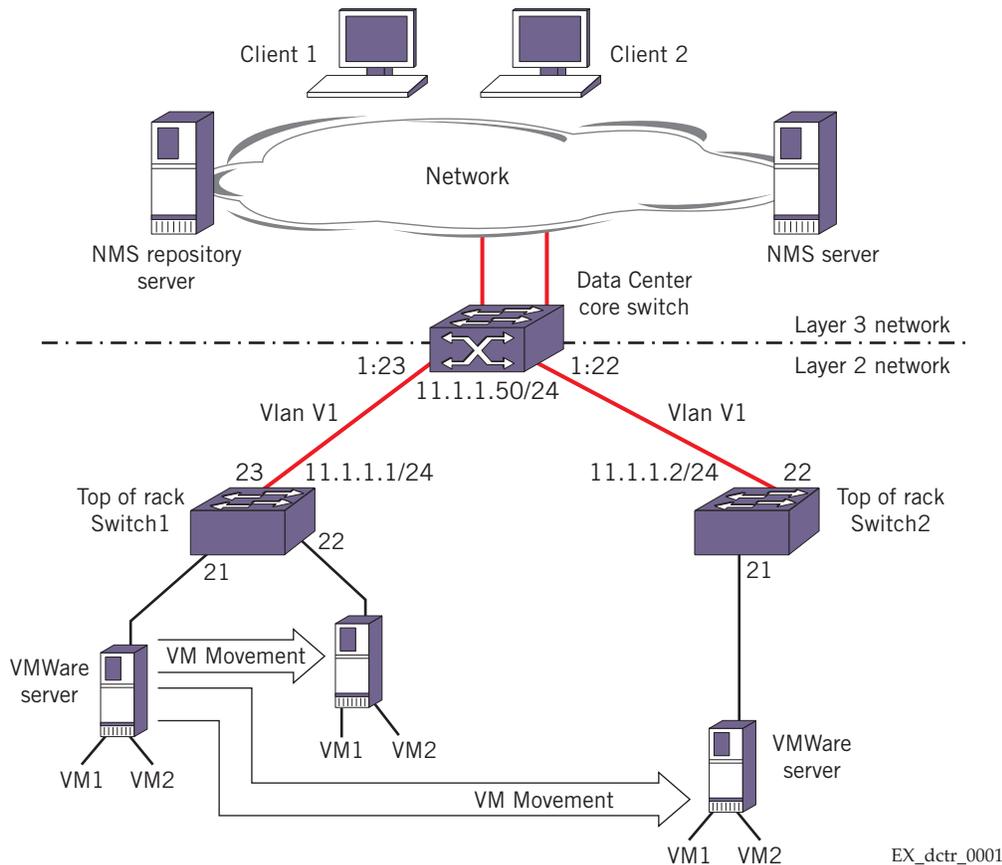
```
show vm-tracking local-vm {mac-address <mac>}
```

Example XNV Configuration

Figure 87 displays a sample XNV topology that will be used for the examples in the following sections:

- [MAC and IP Addresses on page 626](#)
- [General VLAN Configuration on page 627](#)
- [VMWare Server Setup on page 627](#)
- [Repository Server Setup on page 627](#)
- [Example ACL Rules on page 629](#)
- [General Switch XNV Feature Configuration on page 630](#)
- [Local VM Authentication Configuration on page 630](#)
- [Network \(VMMAP\) Authentication Configuration on page 632](#)

- [NMS Server Authentication Configuration on page 634](#)

Figure 87: Sample XNV Topology

The example configuration supports the following:

- VM authentication using NMS server, network, or local authentication
- Ingress and egress port configuration for each VM
- VM movement from one switch port to another
- VM movement from one switch to another

**NOTE**

Ingress ACLs or policies apply to traffic flowing from the VM, into the switch port, and then to the client. Egress ACLs apply to traffic flowing from the client, out the switch port, and to the VM.

MAC and IP Addresses

The following are the MAC and IP addresses for the example topology:

```
VM1 MAC address: 00:04:96:27:C8:23
VM2 MAC address: 00:04:96:27:C8:24
VM1 IP address: 11.1.1.101
VM2 IP address: 11.1.1.102
Client1 MAC address: 00:04:96:00:00:01
```

Client2 MAC address: 00:04:97:00:00:02
Repository server IP address: 10.127.8.1
NMS server IP address: 10.127.5.221

General VLAN Configuration

The following is the core switch VLAN configuration:

```
create vlan v1
configure vlan v1 tag 100
configure vlan v1 add ports 1:22,1:23 tagged
configure vlan v1 ipaddress 11.1.1.50/24
```

The following is the Switch1 VLAN configuration:

```
create vlan v1
configure vlan v1 tag 100
configure vlan v1 add ports 21,22 tagged
configure vlan v1 ipaddress 11.1.1.1/24
```

The following is the Switch2 VLAN configuration:

```
create vlan v1
configure vlan v1 tag 100
configure vlan v1 add ports 21,22 tagged
configure vlan v1 ipaddress 11.1.1.2/24
```



NOTE

For NMS server and network authentication, the NMS server and repository server must be accessible to all XNV-enabled switches through VR-Mgmt.

VMWare Server Setup

The VMWare servers must be connected to Switch1 and Switch2 and should have dual quad-core processors. The VMWare servers require the following software:

- VMWare server: ESXi license
- Vsphere EXSI client
- V-Center client

Each physical VMWare server should be configured with 2 VMs. Use the V-Center client to trigger Vmotion.

Repository Server Setup

The repository server setup for this topology is the same for NMS server authentication and network authentication. The following shows the FTP server setup:

```
FTP login: anonymous
Password: "" (no password)
```

```
Repository directory path: pub
```

```
[root@linux pub]# pwd
/var/ftp/pub
```

The following is an example MANIFEST file:

```
vm.map 2011-05-11 18:57:00
vpp.vpp 2011-05-11 18:57:00
nvpp1.pol 2011-05-11 18:57:00
nevpp1.pol 2011-05-11 18:57:00
nvpp2.pol 2011-05-11 18:57:00
nevpp2.pol 2011-05-11 18:57:00
```

The following is an example VMMAP file named *vm.map*:

```
<VMLIST>
  <VM>
    <MAC>00:04:96:27:C8:23</MAC>
    <NAME>vm_1</NAME>
    <IPV4>11.1.1.101</IPV4>
    <VPP>nvpp1</VPP>
  </VM>
  <VM>
    <MAC>00:04:96:27:C8:24</MAC>
    <NAME>vm_2</NAME>
    <IPV4>11.1.1.102</IPV4>
    <VPP>nvpp2</VPP>
  </VM>
</VMLIST>
```

The following is an example VPP file named *vpp.vpp*:

```
<vppList>
  <vpp>
    <name>nvpp1</name>
    <last-updated>2011-05-30T09:00:00</last-updated>
    <policy>
      <name>nvpp1.pol</name>
      <direction>ingress</direction>
      <order>1</order>
    </policy>
    <policy>
      <name>nevpp1.pol</name>
      <direction>egress</direction>
      <order>1</order>
    </policy>
  </vpp>
  <vpp>
    <name>nvpp2</name>
    <last-updated>2011-05-30T09:00:00</last-updated>
    <policy>
      <name>nvpp2.pol</name>
      <direction>ingress</direction>
      <order>1</order>
    </policy>
    <policy>
      <name>nevpp2.pol</name>
      <direction>egress</direction>
      <order>1</order>
    </policy>
  </vpp>
</vppList>
```

The following is the *nvpp1.pol* file:

```
entry nvpp1 {
  if match all {
    ethernet-destination-address 00:04:96:00:00:00 / ff:ff:ff:00:00:00 ;
  } then {
    deny ;
    count host1
  } }
}
```

The following is the *nvpp2.pol* file:

```
entry nvpp2 {
  if match all {
    ethernet-destination-address 00:04:97:00:00:00 / ff:ff:ff:00:00:00 ;
  } then {
    deny ;
    count host2
  } }
}
```

The following is the *nevpp1.pol* file:

```
entry nevpp1 {
  if match all {
    ethernet-source-address 00:04:96:00:00:00 / ff:ff:ff:00:00:00 ;
  } then {
    deny ;
    count h1
  } }
}
```

The following is the *nevpp2.pol* file:

```
entry nevpp2 {
  if match all {
    ethernet-source-address 00:04:97:00:00:00 / ff:ff:ff:00:00:00 ;
  } then {
    deny ;
    count h2
  } }
}
```

Example ACL Rules

The following are some example ACL rules:

```
entry etherType1 {
  if {
    ethernet-source-address 00:a1:f1:00:00:01;
  }
  then {
    permit;
    count etherType1;
  }
}
entry denyall {
  if {
    source-address 10.21.1.1/32;
  }
}
```

```
        then {
            deny;
        }
    }
entry allowall {
    if {
        source-address 11.1.1.1/32;
        source-address 12.1.0.0/16;
    }
    then {
        allow;
    }
}
entry destIp {
    if {
        destination-address 192.20.1.0/24;
        protocol UDP;
    }
    then {
        deny;
        count destIp;
    }
}
entry denyAll {
    if {
    }
    then {
        deny;
        count denyAll;
    }
}
```

General Switch XNV Feature Configuration

The following configuration enables the XNV feature on the switch and the specified ports:

```
enable vm-tracking
enable vm-tracking ports 21-22
```

Local VM Authentication Configuration

If you only want to use local authentication, configure the XNV-enabled switches as follows:

```
configure vm-tracking authentication database-order local
```

The following is the *policy1.pol* file for Port 21 in the ingress direction:

```
entry nvpp1 {
if match all {
    ethernet-destination-address 00:04:96:00:00:00 / ff:ff:ff:00:00:00 ;
} then {
    deny ;
    count host1
} }
```

The following is the *policy2.pol* file for Port 21 in the egress direction:

```
entry nevpp1 {
if match all {
    ethernet-source-address 00:04:96:00:00:00 / ff:ff:ff:00:00:00 ;
} then {
    deny ;
    count h1
} }
```

The following commands configure VM authentication in the local database:

```
create vm-tracking local-vm mac-address 00:04:96:27:C8:23
configure vm-tracking local-vm mac-address 00:04:96:27:C8:23 ip-address 11.1.1.101
configure vm-tracking local-vm mac-address 00:04:96:27:C8:23 name myVm1
create vm-tracking vpp vpp1
configure vm-tracking vpp vpp1 add ingress policy policy1
configure vm-tracking vpp vpp1 add egress policy policy2
configure vm-tracking local-vm mac-address 00:04:96:27:C8:23 vpp vpp1
```

The following commands display the switch XNV feature status after configuration:

```
* Switch.67 # show vm-tracking local-vm
```

MAC Address	IP Address	Type	Name
00:04:96:27:C8:23	11.1.1.101	VM	myVm1
		VPP	vpp1

```
Number of Local VMs: 1
```

```
* Switch.69 # show vm-tracking vpp
```

VPP Name	Type	Name
vpp1	origin	local
	ingress	policy1
	egress	policy2

```
Number of Local VPPs : 1
```

```
Number of Network VPPs: 0
```

```
Switch.71 # show vm-tracking
```

```
-----
VM Tracking Global Configuration
-----
VM Tracking                : Enabled
VM Tracking authentication order: local
VM Tracking nms reauth period  : 0 (Re-authentication disabled)
VM Tracking blackhole policy   : none
-----
Port                        : 21
VM TRACKING                 : ENABLED
```

```

                Flags
MAC              AP   IP Address      Type      Name
-----
00:04:96:27:C8:23 LB   11.1.1.101    VM        myVm1
                VPP        vpp1
-----

```

```

Flags :
(A)uthenticated : L - Local, N - NMS, V - VMMAP
(P)olicy Applied : B - Both, E - Egress, I - Ingress

```

```

Number of Network VMs Authenticated: 0
Number of Local VMs Authenticated  : 1
Number of VMs Authenticated        : 1

```

```
Switch.73 # show policy
```

```
Policies at Policy Server:
```

```

PolicyName          ClientUsage      Client          BindCount
-----
policy1              1                acl             1
policy2              1                acl             1

```

Network (VMMAP) Authentication Configuration

If you only want to use network authentication, configure the XNV-enabled switches as follows:

```
configure vm-tracking authentication database-order vm-map
```

After the repository server is configured (see [“Repository Server Setup” on page 627](#)), the following commands can be used to display the switch XNV feature status:

```
* Switch.32 # show vm-tracking repository
```

```

-----
VMMAP FTP Server Information
-----
Primary VMMAP FTP Server :
  Server name:
  IP Address      : 10.127.8.1
  VR Name         : VR-Mgmt
  Path Name       : /pub (default)
  User Name       : anonymous (default)

```

```
Secondary VMMAP FTP Server : Unconfigured
```

```

Last sync          : 16:56:11          Last sync server : Primary
Last sync status   : Successful

```

```
* Switch.69 # show vm-tracking vpp
```

```

VPP Name          Type      Name
-----
nvpp1              origin    network
                  ingress    nvpp1
                  egress    nevpp1
nvpp2              origin    network
                  ingress    nvpp2
                  egress    nevpp2

```

Number of Local VPPs : 0
 Number of Network VPPs: 2

* Switch.15 # show vm-tracking

```
-----
VM Tracking Global Configuration
-----
VM Tracking                : Enabled
VM Tracking authentication order: vm-map
VM Tracking nms reauth period  : 0 (Re-authentication disabled)
VM Tracking blackhole policy   : none
-----
```

Port : 21
 VM TRACKING : ENABLED

MAC	Flags		Type	Name
	AP	IP Address		
00:04:96:27:c8:23	VB	11.1.1.101	VM	vm_1
			VPP	nvpp1
00:04:96:27:c8:24	VB	11.1.1.102	VM	vm_2
			VPP	nvpp2

```
-----
Flags :
(A)uthenticated : L - Local, N - NMS, V - VM MAP
(P)olicy Applied : B - Both, E - Egress, I - Ingress
```

Number of Network VMs Authenticated : 2
 Number of Local VMs Authenticated : 0
 Number of VMs Authenticated : 2

* Switch.16 # show vm-tracking network-vm

MAC Address	IP Address	Type	Name
00:04:96:27:c8:23	11.1.1.101	VM	vm_1
		VPP	nvpp1
00:04:96:27:c8:23	11.1.1.102	VM	vm_2
		VPP	nvpp2

Number of Network VMs: 2

* Switch.16 # show policy

Policies at Policy Server:

PolicyName	ClientUsage	Client	BindCount
vmt/nvpp1	1	acl	1
vmt/nvpp2	1	acl	1
vmt/nevpp1	1	acl	1
vmt/nevpp2	1	acl	1

NMS Server Authentication Configuration

If you only want to use NMS server authentication, configure the XNV-enabled switches as follows:

```
configure vm-tracking authentication database-order nms
```

Configure the NMS server as follows:

- Add Switch1 and Switch2 as RADIUS clients
- Add the MAC addresses for VM1 and VM2 as users, and configure the passwords to match the user names
- Add a remote access policy with the Extreme Networks VSAs:
 - Vendor code: 1916
 - VSA ID: 213 (EXTREME_VM_NAME)
Example: MyVM1
 - VSA ID: 214 (EXTREME_VM_VPP_NAME)
Example: nvpp1
 - VSA ID: 215 (EXTREME_VM_IP_ADDR)
Example: 11.1.1.254

The following command configures the switch as an NMS server client:

```
configure vm-tracking nms primary server 10.127.5.221 client-ip 10.127.8.12 shared-secret secret
```

After the repository server is configured (see [“Repository Server Setup” on page 627](#)), the following commands can be used to display the switch XNV feature status:

```
* Switch.33 # show vm-tracking nms server
VM Tracking NMS : enabled
VM Tracking NMS server connect time out: 3 seconds
Primary VM Tracking NMS server:
  Server name      :
  IP address       : 10.127.5.221
  Server IP Port   : 1812
  Client address   : 10.127.8.12 (VR-Mgmt)
  Shared secret    : qijxou
Access Requests   : 7                Access Accepts : 2
Access Rejects    : 5                Access Challenges : 0
Access Retransmits: 0                Client timeouts : 0
Bad authenticators: 0                Unknown types  : 0
Round Trip Time   : 0

* Switch.32 # show vm-tracking
-----
VM Tracking Global Configuration
-----
VM Tracking                : Enabled
VM Tracking authentication order: nms
VM Tracking nms reauth period : 0 (Re-authentication disabled)
VM Tracking blackhole policy  : none
-----

Port                        : 21
VM TRACKING                 : ENABLED
```

```

                Flags
MAC            AP    IP Address    Type    Name
-----
00:04:96:27:c8:23  VB    11.1.1.101    VM      vm_1
                                VPP      nvpp1
00:04:96:27:c8:24  VB    11.1.1.102    VM      vm_2
                                VPP      nvpp2
-----
Flags :
(A)uthenticated : L - Local, N - NMS, V - VMMAP
(P)olicy Applied : B - Both, E - Egress, I - Ingress

Number of Network VMs Authenticated: 1
Number of Local VMs Authenticated : 0
Number of VMs Authenticated : 1

* Switch.32 # show policy
Policies at Policy Server:
PolicyName ClientUsage Client BindCount
-----
vmt/nvpp1 1 acl 1
vmt/nvpp2 1 acl 1
-----

```

Managing Direct Attach to Support VEPA

You should only enable the direct attach feature on ports that directly connect to a VM server running VEPA software. To enable or disable the direct attach feature on a port, use the following command:

```
configure port <port> reflective-relay [on | off]
```

To see if the direct attach feature (reflective-relay) is enabled on a switch port, enter the `show ports information detail` command.



NOTE

When the Direct Attach feature is configured on a port, the port number cannot be included in the port list for a static FDB entry. For example, the Direct-Attach enabled port can be the only port number specified in a static FDB entry, but it cannot be included in a port-list range for a static FDB entry.

Managing the FIP Snooping Feature

This section provides the following FIP snooping topics:

- [Introduction to FIP Snooping on page 636](#)
- [Extreme's Implementation of FIP Snooping on page 636](#)
- [Example FIP Snooping Configuration on page 636](#)

Introduction to FIP Snooping

Many data centers use ethernet for TCP/IP networks and Fibre Channel for storage area networks (SANs). Implementing Fibre Channel over ethernet (FCoE) allows transmission over ethernet networks, while preserving Fibre Channel's lossless, point-to-point transmission ability for reliable and efficient access of disk servers. FCoE is part of the International Committee for Information Technology Standards T11 FC-BB-5 standard.

FCoE Initialization Protocol (FIP) allows ethernet nodes (Enode) to find, and set up virtual links with, FCoE forwarders (FCFs) that then connect to the fibre channel fabric.

FIP snooping monitors FCoE's virtual links and suppresses traffic not related to maintaining or establishing these virtual links to achieve a level of security comparable to native Fibre Channel.

FIP Snooping Requirements

FIP snooping requires the following capabilities:

- Priority flow control (PFC) enabled
- Data center bridging capability exchange (DCBX) enabled
- FCoE application priority advertised by DCBX

Extreme's Implementation of FIP Snooping

This section describes Extreme Network's implementation of FIP snooping in more detail.

Supported Platforms

FIP snooping is supported on the following Extreme platforms:

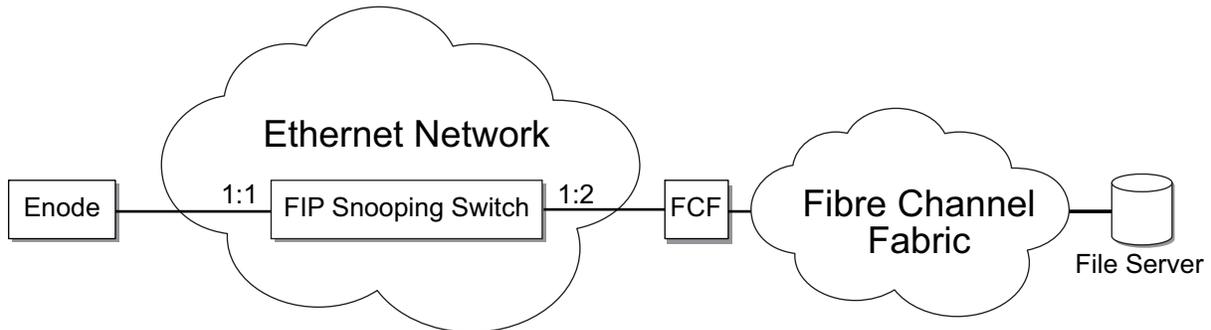
- BlackDiamond X8
- BlackDiamond 8800 series BD 8900-40G6X-xm
- Summit X670
- Summit X650 40G VIM
- Summit X650-24t
- Summit X650-24x

Limitations

- VLAN discovery is not supported, only configured FIP VLANs.
- Virtual links between FCFs are not monitored.

Example FIP Snooping Configuration

Figure 88 illustrates an example FIP snooping configuration.

Figure 88: Example FIP Snooping Configuration

The following commands enable FIP snooping on VLAN “v1,” with two ports (1:1 and 1:2) with PFC, jumbo frames, and DCBX enabled.

```

create vlan "v1"
configure vlan v1 tag 20
configure vlan v1 add ports 1:1-2 tagged
create qosprofile qp4
configure qosscheduler weighted-round-robin
configure qosprofile qp4 weight 1
enable jumbo-frame ports 1:1-2
enable flow-control rx-pause qosprofile qp4 ports 1:1-2
enable flow-control tx-pause priority 3 ports 1:1-2
enable lldp ports 1:1-2
configure lldp ports 1:1-2 advertise vendor-specific dcbx baseline
configure lldp ports 1:1-2 dcbx add application name fcoe priority 3
configure lldp ports 1:1-2 dcbx add application name fip priority 3
configure fip snooping add vlan v1
configure fip snooping vlan v1 port 1:1 location perimeter
configure fip snooping vlan v1 port 1:2 location fcf-to-enode
enable fip snooping vlan v1
  
```


16

CHAPTER

Virtual Routers

This chapter includes the following sections:

- [Overview on page 639](#)
- [Managing Virtual Routers on page 642](#)
- [Virtual Router Configuration Example on page 647](#)

Overview

The ExtremeXOS software supports virtual routers (VRs). This capability allows a single physical switch to be split into multiple VRs. This feature separates the traffic forwarded by a VR from the traffic on a different VR.

Each VR maintains a separate logical forwarding table, which allows the VRs to have overlapping IP addressing. Because each VR maintains its own separate routing information, packets arriving on one VR are never switched to another.



NOTE

VRs should not be connected together through a Layer 2 domain. Since there is a single MAC address per switch in the ExtremeXOS software, this same MAC address is used for all VRs. If two VRs on the same switch are connected through a Layer 2 domain, the intermediate Layer 2 switches learn the same MAC address of the switch on different ports, and may send traffic into the wrong VR.

Ports on the switch can either be used exclusively by one VR, or can be shared among two or more VRs. One reason to configure a port for the exclusive use of a single VR is to be sure that only packets from that VR egress from that port. One reason to configure a port to be shared by multiple VRs is to pass traffic from multiple VRs across a shared link.

Each VLAN can belong to only one VR.

Because a single physical switch supports multiple VRs, some commands in the ExtremeXOS software require you to specify to which VR the command applies. For example, when you use the ping command, you must specify from which VR the ping packets are generated. Many commands that deal with switch management use the management VR by default. See the *ExtremeXOS Command Reference Guide* for information on the defaults for individual commands.

**NOTE**

The term VR is also used with the Virtual Router Redundancy Protocol (VRRP). VRRP uses the term to refer to a single VR that spans more than one physical router, which allows multiple switches to provide redundant routing services to users. For more information about VRRP, see [Chapter 29, “VRRP Commands.”](#)

Types of Virtual Routers

The following sections introduce the types of VRs in an ExtremeXOS system:

- [System Virtual Routers on page 640](#)
- [User Virtual Routers on page 641](#)
- [VRFs on page 641](#)

System Virtual Routers

The system VRs are the three VRs created at boot-up time. These system VRs cannot be deleted or renamed. They are named *VR-Mgmt*, *VR-Control*, and *VR-Default*. The following describes each system VR:

- *VR-Mgmt*

VR-Mgmt enables remote management stations to access the switch through Telnet, SSH, and SNMP sessions; and it owns the management port. No other ports can be added to *VR-Mgmt*, and the management port cannot be removed from it.

The *Mgmt* VLAN is created in *VR-Mgmt* during ExtremeXOS system boot-up. No other VLAN can be created in this VR, and the *Mgmt* VLAN cannot be deleted from it.

No routing protocol is running on or can be added to *VR-Mgmt*.

VR-Mgmt is called *VR-0* in ExtremeXOS releases before 11.0.

- *VR-Control*

VR-Control is used for internal communications between all the modules and subsystems in the switch. It has no external visible ports, and you cannot assign any port to it.

VR-Control has no VLAN interface, and no VLAN can be created for it.

No routing protocol is running on or can be added to *VR-Control*.

VR-Control is called *VR-1* in ExtremeXOS releases before 11.0.

- *VR-Default*

VR-Default is the default VR created by the ExtremeXOS system. By default, all data ports in the switch are assigned to *VR-Default*. Any data port can be added to and deleted from *VR-Default*.

Users can create and delete VLANs in *VR-Default*. The *Default* VLAN is created in *VR-Default* during the ExtremeXOS system boot-up. The *Default* VLAN cannot be deleted from *VR-Default*.

One instance of each routing protocol is spawned for *VR-Default* during the ExtremeXOS system boot-up, and these routing instances cannot be deleted.

VR-Default is called *VR-2* in ExtremeXOS releases before 11.0.

User Virtual Routers

User VRs are the VRs created by users in addition to the system VRs, and each user VR supports Layer 3 routing and forwarding. The routing tables for each VR are separate from the tables for other VRs, so user VRs can support overlapping address space.



NOTE

User VRs are supported only on the platforms listed for the VR feature in [Table 139](#) in [Appendix A, “Feature License Requirements.”](#) When a modular switch or SummitStack contains modules or switches that do not support user VRs, the ports on those devices cannot be added to a user VR.

When a new user VR is created, by default, no ports are assigned, no VLAN interface is created, and no support for any routing protocols is added. User VRs support all switch routing protocols. When you add a protocol to a user VR, the user VR starts a switch process for that protocol. The ExtremeXOS software supports up to 63 user VRs, each of which supports protocols for that VR and all child VRFs.

VRFs

Virtual Router and Forwarding instances (VRFs) are similar to VRs. VRFs are created as *children* of user VRs or *VR-Default*, and each VRF supports Layer 3 routing and forwarding. The routing tables for each VRF are separate from the tables for other VRs and VRFs, so VRFs can support overlapping address space. The primary differences between VRs and VRFs are:

- For each routing protocol added to a VRF, only one process is started in the parent VR. The VRF protocol operates as one instance of the parent VR protocol, and additional child VRFs operate as additional instances of the same parent VR protocol process. VRFs allow a protocol process running in the parent VR to support many virtual router instances.
- ExtremeXOS supports up to 63 VRs and up to many more VRFs. (For the maximum number of supported VRFs, see the *ExtremeXOS Release Notes*.)
- [In this release, VRFs support only static routes. VRFs do not support dynamic routing protocols.](#)

Use VRFs instead of VRs when your network plan calls for more than 63 virtual routers. Use VRs instead of VRFs when the routing protocol you want to use is not supported on a VRF.



NOTE

VRFs are supported only on the platforms listed for the VRF feature in [Table 139](#) in [Appendix A, “Feature License Requirements.”](#) When a modular switch or SummitStack contains modules or switches that do not support VRFs, the ports on those devices cannot be added to a VRF.

VR Configuration Context

Each VR and VRF has its own configuration domain or *context*, in which you can enter commands to configure that VR. Some commands allow you to specify a VR to which the command applies. For other commands, you must change context to that of the target VR or VRF before you execute the command. The current context is indicated in the command line interface (CLI) prompt by the name of the user VR or VRF. If no name appears in the prompt, the context is *VR-Default*.

For instructions on changing context, see [“Changing the VR Context” on page 644](#).

Commands that apply to the current VR context include all the BGP, OSPF, OSPFv3, PIM, IS-IS, RIP, and RIPng commands, and the commands listed in [Table 69](#). Commands that apply to the current VRF context are limited to BGP commands and the commands listed in [Table 69](#).

Table 69: Virtual Router Commands

```
[enable | disable] ipforwarding
clear iparpa
clear counters iparpa
configure iparpa
configure iparp [add | delete]a
[enable | disable] iparpa
show iparpa
configure iproute [add | delete]a
show iproutea
show ipstatsa
rtlookup
create [vlan | vman] <vlan-name>
[enable | disable] igmp
[enable | disable] igmp snoopinga
[enable | disable] ipmcf forwarding
show igmp
show igmp snooping
show igmp group
show igmp snooping cache
```

a. Other commands are available with these listed.

Managing Virtual Routers

To use the user VR functionality in the ExtremeXOS software, you need to complete the tasks described in the following sections:

- [Creating and Deleting User Virtual Routers on page 643](#)
- [Creating and Deleting VRFs on page 643](#)
- [Enabling and Disabling VRFs on page 644](#)
- [Configuring and Removing a VR Description on page 644](#)
- [Changing the VR Context on page 644](#)
- [Adding and Deleting Routing Protocols on page 644](#)
- [Configuring Ports to Use One or More Virtual Routers on page 645](#)
- [Displaying Ports and Protocols on page 646](#)
- [Configuring the Routing Protocols and VLANs on page 646](#)

Creating and Deleting User Virtual Routers

To create a user VR, use the following command and do not include the `type` or `vr` attributes:

```
create virtual-router <vr-name> {type vrf} {vr <parent_vr_name>}}
```



NOTE

User VRs are supported only on the platforms listed for this feature in [Table 139](#) in [Appendix A, “Feature License Requirements.”](#)

A VR name cannot be the same as a VLAN name. You cannot name a user VR with the names *VR-Mgmt*, *VR-Control*, or *VR-Default* because these are the existing default system VRs. For backward compatibility, user VRs also cannot be named *VR-0*, *VR-1* or *VR-2*, because these three names are the names for the system VRs in ExtremeXOS releases before 11.0.

If you exceed the maximum number of VRs supported on your platform, a message similar to the following appears:

```
Error: Maximum number of User VRs supported by the system is 63
```

To display the virtual routers, use the following command:

```
show virtual-router {<name>}
```

To delete a user VR, use the following command:

```
delete virtual-router <vr-name>
```

Before you delete a VR, you must delete all VLANs and child VRFs created in that VR. All of the ports assigned to this VR are deleted and made available to assign to other VRs and VRFs. Any routing protocol that is running on the VR is shut down and deleted gracefully.

Creating and Deleting VRFs

To create a VRF, use the following command and include the `type` attribute:

```
create virtual-router <vr-name> {type vrf} {vr <parent_vr_name>}}
```



NOTE

VRFs are supported only on the platforms listed for this feature in [Table 139](#) in [Appendix A, “Feature License Requirements.”](#)

A VRF name cannot be the same as a VLAN or VR name.

To display the VRFs, use the following command:

```
show virtual-router {<name>}
```

To delete a VRF, use the following command:

```
delete virtual-router <vr-name>
```

Before you delete a VRF, you must delete all VLANs and stop all protocols that are assigned to that VRF. All of the ports assigned to a deleted VRF are deleted and made available to assign to other VRs and VRFs. Any routing protocol instance that is assigned to the VRF is deleted gracefully.

Enabling and Disabling VRFs

VRFs are enabled when created. To disable or enable a VRF, use the following commands:

```
disable virtual-router <vrf-name>
enable virtual-router <vrf-name>
```

Configuring and Removing a VR Description

A VR description is a text message that can be used to label the VR. The text message is for viewing and SNMP MIB reports only; it has no affect on VR operation. To configure or remove a description, use the following commands:

```
configure vr <name> description <string>
unconfigure vr <name> description
```

Changing the VR Context

The VR context is introduced in “[VR Configuration Context](#)” on page 641.

To switch to a context for a different VR, use the following command:

```
virtual-router {<vr-name>}
```

The CLI prompt displays the VR context.

Adding and Deleting Routing Protocols

When a user VR is created, no resources are allocated for routing protocols. You must add the routing protocols needed for your VR before you attempt to configure them.

The maximum number of protocols supported is 64. This provides for the following protocols:

- The basic 7 protocols on VR-Default (RIP, OSPF, BGP, PIM, ISIS, OSPFv3, and RIPNG)
- 1 MPLS protocol instance on any VR (only on platforms that support MPLS)
- 56 additional protocols for user VRs. Any combination of the 7 protocols supported on user VRs (RIP, OSPF, BGP, PIM, ISIS, OSPFv3, and RIPNG) can be assigned to user VRs, up to a maximum number of 56.

When you add a protocol to a user VR, the software starts a process to support the protocol, but it does not enable that protocol. After you add a protocol to a user VR, you must specifically enable and configure that protocol before it starts.

When you add a protocol to a VRF, a protocol process is started in the parent VR (if it is not already started) and a protocol instance is created inside that process for this VRF.



NOTE

You must add, configure, and enable a protocol for a VR before you start unicast or multicast forwarding on the VR and before you configure any features (such as VLANs) to use the VR.

To add a protocol to a VR, use the following command:

```
configure vr <name> add protocol <protocol-name>
```

If you add more than the maximum number of protocols, the following message appears:

```
Error: Maximum number of Protocols that can be started in the system is 64
```

To remove a protocol from a VR, use the following command:

```
configure vr <vr-name> delete protocol <protocol-name>
```

Configuring Ports to Use One or More Virtual Routers

By default, all the user data ports belong to *VR-Default* and the default VLAN, *Default*. All these ports are used exclusively by *VR-Default*. To configure a port to use one or more virtual routers, you need to perform one or more of the tasks described in the following sections:

- [Deleting Ports from a Virtual Router on page 645](#)
- [Adding Ports to a Single Virtual Router on page 645](#)
- [Adding Ports to Multiple Virtual Routers on page 645](#)

Deleting Ports from a Virtual Router

To configure a port for exclusive use by another VR, or for use by multiple VRs, it must first be deleted from *VR-Default*. You must delete the port from any VLAN it belongs to before deleting it from a VR.

To delete a port from a VR, use the following command:

```
configure vr <vr-name> delete ports <portlist>
```



CAUTION

Do not create Layer 2 connections between ports assigned to different VRs in the same switch. Because each switch supports just one MAC address, every VR in the switch uses the same MAC address. A Layer 2 connection between two VRs can cause external devices to direct traffic to the wrong VR.

Adding Ports to a Single Virtual Router

When you add a port to a VR, that port can only be used by that VR.

To add a port to a single VR, use the following command:

```
configure vr <vr-name> add ports <portlist>
```

The following example demonstrates how to remove all the ports on slot 3 from the *Default* VLAN in *VR-Default* and add them for the exclusive use of user VR *helix*:

```
configure vlan default delete ports 3:*
configure vr vr-default delete ports 3:*
configure vr helix add ports 3:*
```

Adding Ports to Multiple Virtual Routers

To use a port in multiple VRs, do not add the port to a VR as described in the previous section. Add the port to a VLAN in the desired VR.

**NOTE**

See [Chapter 20, “QoS”](#) for details about how multiple VRs per port can affect DiffServ and code replacement.

**NOTE**

You should configure any protocols you want to use on a user VR before you add a VLAN to the user VR. When IP multicast forwarding will be supported on a user VR, add the PIM protocol before you enable IP multicast forwarding.

The following example demonstrates how to add port 3:5 to user VRs *VR-green* and *VR-blue*. The tagged VLAN *bldg_200* was previously configured in *VR-green*, and the tagged VLAN *bldg_300* was previously configured in *VR-blue*.

```
configure vlan default delete ports 3:5
configure vr vr-default delete ports 3:5
configure vlan bldg_200 add ports 3:5 tagged
configure vlan bldg_300 add ports 3:5 tagged
```

Displaying Ports and Protocols

You can display the ports, protocols, and names of protocol processes for a VR by using the following command:

```
show virtual-router {<name>}
```

Configuring the Routing Protocols and VLANs

After a user VR is created, the ports are added, and support for any required routing protocols is added, you can configure the VR.

To create a VLAN in a VR, use the following command:

```
create vlan <vlan_name> {description <vlan-description>} {vr <name>}
```

If you do not specify a VR in the `create vlan` command, the VLAN is created in the current VR context.

VLAN names must conform to the guidelines specified in [“Object Names” on page 42](#).

**NOTE**

All VLAN names and VLAN IDs on a switch must be unique, regardless of the VR in which they are created. You cannot have two VLANs with the same name, even if they are in different VRs.

To display the VLANs in a specific VR, use the following command:

```
show vlan virtual-router <vr-name>
```

which is a specific form of this command:

```
show vlan {virtual-router <vr-name>}
```

You can also configure routing protocols by using the standard ExtremeXOS software commands. The routing configurations of the different VRs are independent of each other.

Virtual Router Configuration Example

The following example demonstrates how to:

- Create a user VR named *helix*.
- Remove ports from the VLAN *Default* and *VR-Default*.
- Add ports to user VR *helix*.
- Add the OSPF protocol to user VR *helix*.
- Set the VR context to *helix*, so that subsequent VR commands affect VR *helix*.
- Create a VLAN named *helix-accounting*.
- Add ports that belong to user VR *helix* to the *helix-accounting* VLAN.

The CLI prompt is shown in this example to show how the VR context appears. At the end of the example, the VR is ready to be configured for OSPF, using ExtremeXOS software commands.

```
* BD10K.1 # create virtual-router helix
* BD10K.2 # configure vlan default delete ports 3:*
* BD10K.3 # configure vr vr-default delete ports 3:*
* BD10K.4 # configure vr helix add ports 3:*
* BD10K.5 # configure vr helix add protocol ospf
* BD10K.6 # virtual-router helix
* (vr helix) BD10K.7 # create vlan helix-accounting
* (vr helix) BD10K.8 # configure helix-accounting add ports 3:1
* (vr helix) BD10K.9 #
```


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CHAPTER

Policy Manager

This chapter includes the following sections:

- [Overview on page 649](#)
- [Creating and Editing Policies on page 649](#)
- [Checking Policies on page 651](#)
- [Refreshing Policies on page 651](#)
- [Applying Policies on page 652](#)

Overview

One of the processes that make up the ExtremeXOS system is the policy manager. The policy manager is responsible for maintaining a set of policy statements in a policy database and communicating these policy statements to the applications that request them.

Policies are used by the routing protocol applications to control the advertisement, reception, and use of routing information by the switch. Using policies, a set of routes can be selectively permitted (or denied) based on their attributes, for advertisements in the routing domain. The routing protocol application can also modify the attributes of the routing information, based on the policy statements.

Policies are also used by the access control list (ACL) application to perform packet filtering and forwarding decisions on packets. The ACL application will program these policies into the packet filtering hardware on the switch. Packets can be dropped, forwarded, moved to a different QoS profile, or counted, based on the policy statements provided by the policy manager.

Creating and Editing Policies

A policy is created by writing a text file that contains a series of rule entries describing match conditions and actions to take. Policies are created by writing a text file on a separate machine and then downloading it to the switch. Once on the switch, the file is then loaded into a policy database to be used by applications on the switch. Policy text files can also be created and edited directly on the switch.

**NOTE**

Although ExtremeXOS does not prohibit mixing ACL and routing type entries in a policy file, it is strongly recommended that you do not mix the entries, and you use separate policy files for ACL and routing policies.

When you create a policy file, name the file with the policy name that you will use when applying the policy, and use “.pol” as the filename extension. For example, the policy name “boundary” refers to the text file “boundary.pol”.

Using the Edit Command

A VI-like editor is available on the switch to edit policies. To edit a policy file on the switch by launching the editor, use the following command:

```
edit policy
```

There are many commands available with the editor. For information about the editor commands, use any tutorial or documentation about VI. The following is only a short introduction to the editor.

Edit operates in one of two modes; command and input. When a file first opens, you are in the command mode. To write in the file, use the keyboard arrow keys to position your cursor within the file, then press one of the following keys to enter input mode:

- i - To insert text ahead of the initial cursor position
- a - To append text after the initial cursor position

To escape the input mode and return to the command mode, press the Escape key.

Several commands can be used from the command mode. The following commands are the most commonly used:

- dd - To delete the current line
- yy - To copy the current line
- p - To paste the line copied
- :w - To write (save) the file
- :q - To quit the file if no changes were made
- :q! - To forcefully quit the file without saving changes
- :wq - To write and quit the file

Using a Separate Machine

You can also edit policies on a separate machine. Any common text editor can be used to create a policy file. The file is then transferred to the switch using TFTP and then applied.

To transfer policy files to the switch, use the following command:

```
tftp [<host-name> | <ip-address>] {-v <vr_name>} [-g | -p] [{-l [internal-memory  
<local-file-internal> | memorycard <local-file-memcard> | <local-file>} {-r <remote-  
file>} | {-r <remote-file>} {-l [internal-memory <local-file-internal> | memorycard  
<local-file-memcard> | <local-file>}]}
```

Checking Policies

A policy file can be checked to see if it is syntactically correct. To check the policy syntax, use the following command:

```
check policy
```

This command can only determine if the syntax of the policy file is correct and can be loaded into the policy manager database. Since a policy can be used by multiple applications, a particular application may have additional constraints on allowable policies.

Refreshing Policies

When a policy file is changed (such as adding, deleting an entry, adding/deleting/modifying a statement), the information in the policy database does not change until the policy is refreshed. The user must refresh the policy so that the latest copy of policy is used.

When the policy is refreshed, the new policy file is read, processed, and stored in the server database. Any clients that use the policy are updated. To refresh the policy, use the following command:

```
refresh policy
```

For ACL policies only, during the time that an ACL policy is refreshed, packets on the interface are blackholed, by default. This is to protect the switch during the short time that the policy is being applied to the hardware. It is conceivable that an unwanted packet could be forwarded by the switch as the new ACL is being set up in the hardware. You can disable this behavior. To control the behavior of the switch during an ACL refresh, use the following commands:

```
enable access-list refresh blackhole  
disable access-list refresh blackhole
```

In releases previous to ExtremeXOS 11.4, when ACLs were refreshed, all the ACL entries were removed, and new ACL entries were created to implement the newly applied policy. Beginning in release 11.4, the policy manager uses Smart Refresh to update the ACLs. When a change is detected, only the ACL changes needed to modify the ACLs are sent to the hardware, and the unchanged entries remain. This behavior avoids having to blackhole packets because the ACLs have been momentarily cleared. Smart Refresh works well up to 200 changes. If the number of changes exceeds 200, you will see this message: Policy file has more than 200 new rules. Smart refresh can not be carried out. Following this message, you will see a prompt based on the current blackhole configuration. If blackhole is disabled you will see the following prompt:

```
Note, the current setting for Access-list Refresh Blackhole is Disabled. WARNING: If a  
full refresh is performed, it is possible packets that should be denied may be  
forwarded through the switch during the time the access list is being installed.  
Would you like to perform a full refresh?
```

If blackhole is enabled, you will see the following prompt:

```
Note, the current setting for Access-list Refresh Blackhole is Enabled.  
Would you like to perform a full refresh?
```

To take advantage of Smart Refresh, disable access-list refresh blackholing.



NOTE

Smart refresh is not performed for policies if the number of entries in the policy change during refresh.

Applying Policies

ACL policies and routing policies are applied using different commands.

Applying ACL Policies

A policy intended to be used as an ACL is applied to an interface, and the CLI command option is named `<aclname>`. Supply the policy name in place of the `<aclname>` option. To apply an ACL policy, use the following command:

```
configure access-list <aclname> [any | ports <portlist> | vlan <vlanname>] {ingress | egress}
```

When you use the `any` keyword, the ACL is applied to all the interfaces and is referred to as the wildcard ACL. This ACL is evaluated for any ports without specific ACLs, and it is also applied to any packets that do not match the specific ACLs applied to the interfaces.

When an ACL is already configured on an interface, the command is rejected and an error message is displayed.

To remove an ACL from an interface, use the following command:

```
unconfigure access-list <policy-name> {any | ports <portlist> | vlan <vlanname>} {ingress | egress}
```

To display the interfaces that have ACLs configured and the ACL that is configured on each, use the following command:

```
show access-list {any | ports <portlist> | vlan <vlanname>} {ingress | egress}
```

Applying Routing Policies

To apply a routing policy, use the command appropriate to the client. Different protocols support different ways to apply policies, but there are some generalities.

Commands that use the keyword `import-policy` are used to change the attributes of routes installed into the switch routing table by the protocol. These commands cannot be used to determine the routes to be added to the routing table. The following are examples for the BGP and RIP protocols:

```
configure bgp import-policy [<policy-name> | none]
configure rip import-policy [<policy-name> | none]
```

Commands that use the keyword `route-policy` control the routes advertised or received by the protocol. Following are examples for BGP and RIP:

```
configure bgp neighbor [<remoteaddr> | all] {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} route-policy [in | out] [none | <policy>]
configure bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} route-policy [in | out] [none | <policy>]
configure rip vlan [<vlan-name> | all] route-policy [in | out] [<policy-name> | none]
```

Other examples of commands that use route policies include:

```
configure ospf area <area-identifier> external-filter [<policy-map> | none]
configure ospf area <area-identifier> interarea-filter [<policy-map> | none]
configure rip vlan [<vlan-name> | all] trusted-gateway [<policy-name> | none]
```

To remove a routing policy, use the `none` option in the command.

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CHAPTER

ACLs

This chapter includes the following sections:

- [Overview on page 655](#)
- [ACL Rule Syntax on page 656](#)
- [Layer-2 Protocol Tunneling ACLs on page 669](#)
- [ACL Byte Counters on page 670](#)
- [Dynamic ACLs on page 671](#)
- [Network-Zone Support in ACLs on page 677](#)
- [ACL Evaluation Precedence on page 682](#)
- [Applying ACL Policy Files on page 684](#)
- [ACL Mechanisms on page 688](#)
- [Policy-Based Routing on page 706](#)
- [ACL Troubleshooting on page 714](#)

Overview

Access Control Lists (ACLs) are used to define packet filtering and forwarding rules for traffic traversing the switch. Each packet arriving on an ingress port and/or VLAN is compared to the access list applied to that interface and is either permitted or denied. Packets egressing an interface can also be filtered on the platforms listed for this feature in [Appendix A, “Feature License Requirements.”](#) However, only a subset of the filtering conditions available for ingress filtering are available for egress filtering.

In addition to forwarding or dropping packets that match an ACL, the switch can also perform additional operations such as incrementing counters, logging packet headers, mirroring traffic to a monitor port, sending the packet to a QoS profile, and metering the packets matching the ACL to control bandwidth (metering is supported only on the platforms listed for this feature in [Appendix A, “Feature License Requirements”](#)). Using ACLs has no impact on switch performance (with the minor exception of the mirror-cpu action modifier).

ACLs are typically applied to traffic that crosses Layer 3 router boundaries, but it is possible to use access lists within a Layer 2 virtual LAN (VLAN).

ACLs in ExtremeXOS apply to all traffic. This is somewhat different from the behavior in ExtremeWare. For example, if you deny all the traffic to a port, *no* traffic, including control packets, such as OSPF or RIP, will reach the switch and the adjacency will be dropped. You must explicitly allow those types of packets (if desired). In ExtremeWare, an ACL that denied “all” traffic would allow control packets (those bound for the CPU) to reach the switch.

ACLs are created in two different ways. One method is to create an ACL policy file and apply that ACL policy file to a list of ports, a VLAN, or to all interfaces.

**NOTE**

ACLs applied to a VLAN are actually applied to all ports on the switch, without regard to VLAN membership. The result is that resources are consumed per chip on BlackDiamond 8000 c-, e- xl-, and xm-series modules and Summit family switches.

An ACL policy file is a text file that contains one or more ACL rule entries. This first method creates ACLs that are persistent across switch reboots, can contain a large number of rule entries, and are all applied at the same time. See [“ACL Rule Syntax” on page 656](#) for information about creating ACL rule entries. For information about creating policy files, see [Chapter 17, “Policy Manager”](#).

Policy files are also used to define routing policies. Routing policies are used to control the advertisement or recognition of routes communicated by routing protocols. ACL policy files and routing policy files are both handled by the policy manager, and the syntax for both types of files is checked by the policy manager.

**NOTE**

Although ExtremeXOS does not prohibit mixing ACL and routing type entries in a policy file, it is strongly recommended that you do not mix the entries and do use separate policy files for ACL and routing policies.

The second method to create an ACL is to use the CLI to specify a single rule, called a dynamic ACL. By default, dynamic ACLs persist across reboots; however, you can configure non-persistent dynamic ACLs that disappear when the switch reboots. Dynamic ACLs consist of only a single rule. Multiple dynamic ACLs can be applied to an interface. See [“Layer-2 Protocol Tunneling ACLs” on page 669](#) for information about creating dynamic ACLs. The precedence of ACLs can be configured by defining zones and configuring the priority of both the zones and the ACLs within a zone. See [“Configuring ACL Priority” on page 673](#) for more information.

ACL Rule Syntax

An ACL rule entry consists of:

- A rule entry name, unique within the same ACL policy file or among Dynamic ACLs.
- Zero or more match conditions.
- Zero or one action (permit or deny). If no action is specified, the packet is permitted by default.
- Zero or more action modifiers.

Each rule entry uses the following syntax:

```
entry <ACLrulename>{
  if {
    <match-conditions>;
  } then {
    <action>;
    <action-modifiers>;
  }
}
```

The following is an example of a rule entry:

```
entry udpacl {
  if {
    source-address 10.203.134.0/24;
    destination-address 140.158.18.16/32;
    protocol udp;
    source-port 190;
    destination-port 1200 - 1250;
  } then {
    permit;
  }
}
```

An ACL rule is evaluated as follows:

- If the packet matches all the match conditions, the action and any action modifiers in the `then` statement are taken.
- For ingress ACLs, if a rule entry does not contain any match condition, the packet is considered to match and the action and any action modifiers in the rule entry's `then` statement are taken. For egress ACLs, if a rule entry does not contain any match condition, no packets will match. See [“Matching All Egress Packets”](#) for more information.
- If the packet matches all the match conditions, and if there is no action specified in the `then` statement, the action `permit` is taken by default.
- If the packet does not match all the match conditions, the action in the `then` statement is ignored.

This section describes the following topics:

- [Matching All Egress Packets on page 657](#)
- [Comments and Descriptions in ACL Policy Files on page 658](#)
- [Types of Rule Entries on page 659](#)
- [Match Conditions on page 659](#)
- [Actions on page 659](#)
- [Action Modifiers on page 660](#)
- [ACL Rule Syntax Details on page 662](#)

Matching All Egress Packets

Unlike ingress ACLs, for egress ACLs you must specify either a source or destination address, instead of writing a rule with no match conditions.

For example, an ingress ACL deny all rule could be:

```
entry DenyAllIngress{
  if {
  } then {
    deny;
  }
}
```

The previous rule would not work as an egress ACL. The following is an example of an egress ACL deny all rule:

```
entry DenyAllEgress{
  if {
    source-address 0.0.0.0/0;
  } then {
    deny;
  }
}
```

Comments and Descriptions in ACL Policy Files

In ACL policy files, there are two types of textual additions that have no effect on the ACL actions: comments and descriptions. A comment is ignored by the policy manager and resides only in the policy file. Comments are not saved in the switch configuration and are not displayed by the `show policy` command. A description is saved in the policy manager and is displayed when the ACL is displayed.

You can display the ACL using the following two commands:

```
show policy {<policy-name> | detail}
show access-list {any | ports <portlist> | vlan <vlanname>} {ingress | egress}
```

For example, the following policy, saved in the file `denyping.pol`, contains both a comment and a description:

```
# this line is a comment
@description "This line is a description for the denyping.pol"
entry ping_deny_echo-request {
  if {
    protocol icmp;
    icmp-type echo-request;
  } then {
    deny;
    count pingcount_deny;
  }
}
```

Note that the description begins with the tag `@description` and is a text string enclosed in quotes.

You can apply the policy to port 1, using the following command:

```
configure access-list denyping port 1
```

and display the policy using the following command:

```
show policy denyping
```

The output of this command is similar to the following:

```
Policies at Policy Server:
Policy: denyping
@description This line is a description for the denyping.pol
entry ping_deny_echo-request {
if match all {
    protocol icmp ;
    icmp-type echo-request ;
}
then {
    deny ;
    count pingcount_deny ;
}
}
Number of clients bound to policy: 1
Client: acl bound once
```

Types of Rule Entries

In ExtremeXOS, each rule can be one of following types:

- L2 rule—A rule containing only Layer 2 (L2) matching conditions, such as Ethernet MAC address and Ethernet type
- L3 rule—A rule containing only Layer 3 (L3) matching conditions, such as source or destination IP address and protocol
- L4 rule—A rule containing both Layer 3 (L3) and Layer 4 (L4) matching conditions, such as TCP/UDP port number

Match Conditions

You can specify multiple, single, or zero match conditions. If no match condition is specified, all packets match the rule entry. Commonly used match conditions are:

- `ethernet-source-address <mac-address>`—Ethernet source address
- `ethernet-destination-address <mac-address> <mask>`—Ethernet destination address and mask
- `source-address <prefix>`—IP source address and mask
- `destination-address <prefix>`—IP destination address and mask
- `source-port [<port> | <range>]`—TCP or UDP source port range
- `destination-port [<port> | <range>]`—TCP or UDP destination port range

Table 70 describes all the possible match conditions.

Actions

The actions are:

- `permit`—The packet is forwarded.
- `deny`—The packet is dropped.

The default action is permit, so if no action is specified in a rule entry, the packet is forwarded.

The following actions are supported on all platforms:

- `deny-cpu`—Prevents packets that are copied or switched to the CPU from reaching the CPU. The data-plane forwarding of these packets is unaffected. For example, this action can be used to match broadcast packets and prevent them from reaching the CPU but still allow them to be flooded to other VLAN members. Also, this action can be used to match Spanning Tree Protocol packets and prevent them from reaching the CPU and instead flood them to other VLAN members in certain configurations where Spanning Tree is enabled.
- `copy-cpu-and-drop`—Overrides the above action to facilitate the above action in a “catch-all” rule. It sends matching packets only to the CPU.

Action Modifiers

Additional actions can also be specified, independent of whether the packet is dropped or forwarded. These additional actions are called action modifiers. Not all action modifiers are available on all switches, and not all are available for both ingress and egress ACLs. The action modifiers are:

- `count <countername>`—Increments the counter named in the action modifier (ingress—all platforms) (egress—BlackDiamond X8 series switches, BlackDiamond 8000 c-, xl-, and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit X460, X480, X650, and X670 series switches only. On egress, `count` does not work in combination with `deny` action.)
- `byte-count <byte counter name>`—Increments the byte counter named in the action modifier (ingress only) (BlackDiamond X8 series switches, BlackDiamond 8000 c-, e-, xl-, and xm-series modules, and Summit family switches only)
- `packet-count <packet counter name>`—Increments the packet counter named in the action modifier (ingress only) (BlackDiamond X8 series switches, BlackDiamond 8000 c-, e-, xl- and xm-series modules, and Summit family switches only)
- `log`—Logs the packet header
- `log-raw`—Logs the packet header in hex format
- `meter <metername>`—Takes action depending on the traffic rate (ingress and egress meters are supported on the platforms listed for these features in [Appendix A, “Feature License Requirements.”](#))
- `mirror`—Sends a copy of the packet to the monitor (mirror) port (ingress only, and supported in egress only in x460 and E4G400 switches).
- `mirror-cpu`—Mirrors a copy of the packet to the CPU in order to log it (ingress only)
- `qosprofile <qosprofilename>`—Forwards the packet to the specified QoS profile (ingress—all platforms) (egress—BlackDiamond X8 series switches, BlackDiamond 8000 c-, xl-, and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit X460, X480, X650, and X670 series switches only)
- `redirect <ipv4 addr>`—Forwards the packet to the specified IPv4 address (BlackDiamond X8 series switches, BlackDiamond 8000 c-, e-, xl-, and xm-series modules, and Summit family switches only)
- `redirect-port <port>`—Overrides the forwarding decision and changes the egress port used. If the specified port is part of a load share group then this action will apply the load sharing algorithm. (BlackDiamond X8 series switches, BlackDiamond 8000a-, c-, e-, xl-, and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit family switches only)
- `redirect-port-list`—Supports multiple redirect ports as arguments. When used in an ACL, matching packets are now redirected to multiple ports as specified in the ACL while overriding the default forwarding decision. (Summit X440, X460, X480, X650, X670, E4G-200, E4G-400,

BlackDiamond 8K - 8900-G96T-c, 8900-10G24X-c, 8900-G48T-xl, 8900-G48X-xl, 8900-10G8X-xl, 8900-40G6X-xm, BlackDiamond X8).

- `redirect-port-no-sharing <port>`—Overrides the forwarding decision and changes the egress port used. If the specified port is part of a load share group then this action overrides the load sharing algorithm and directs matching packets to only this port. (BlackDiamond X8 and 8000 series switches, E4G-200 and E4G-400 cell site routers, and Summit family switches)
- `replace-dscp`—Replaces the packet's DSCP field with the value from the associated QoS profile. (ingress—BlackDiamond X8, 8000 c-, e-, xl-, and xm-series modules, and Summit family switches only)
(egress—BlackDiamond X8 series switches, BlackDiamond 8000 c-, xl-, and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit X460, X480, X650, and X670 series switches only)
- `replace-dot1p`—Replaces the packet's 802.1p field with the value from the associated QoS profile (ingress—BlackDiamond X8, 8000 c-, e-, xl-, and xm-series modules, and Summit family switches only)
(egress—BlackDiamond X8 series switches, BlackDiamond 8000 c-, xl-, and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit X460, X480, X650, and X670 series switches only)
- `replace-dot1p-value <value>`—Replaces the packet's 802.1p field with the value specified without affecting the QoS profile assignment (ingress—BlackDiamond X8, 8000 c-, e-, xl-, and xm-series modules and the Summit family switches only)
(egress—BlackDiamond X8 series switches, BlackDiamond 8000 c-, xl-, and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit X460, X480, X650, and X670 series switches only)
- `replace-ethernet-destination-address <mac-address>`—Replaces the packet's destination MAC address; this is applicable only to layer-2 forwarded traffic (BlackDiamond X8, 8000 c-, e-, xl-, and xm-series modules and the Summit family switches only)

Counting Packets and Bytes

When the ACL entry match conditions are met, the specified counter is incremented. The counter value can be displayed by the command:

```
show access-list counter {<countername>} {any | ports <portlist> | vlan <vlaname>}
{ingress | egress}
```

Users of BlackDiamond X8 series switches, BlackDiamond 8000 c-, e-, xl-, and xm-series modules and Summit family switches can use ACL byte counters as an alternative to ACL packet counters. See the section “[ACL Byte Counters](#)” on page 670 for more information.



NOTE

On BlackDiamond X8 series switches, BlackDiamond 8800 series switches and Summit family switches, the maximum number of packets that can be counted with token packet-count or count is 4,294,967,296. On the same switches, the maximum number of bytes that can be counted with byte-count is also 4,294,967,296 which is equivalent to 67,108,864 packets that are sized at 64 bytes.

Logging Packets

Packets are logged only when they go to the CPU, so packets in the fastpath are not automatically logged. You must use both the `mirror-cpu` action modifier and the `log` or `log-raw` action modifier if you want to log both slowpath and fastpath packets that match the ACL rule entry. Additionally, Kern.Info messages (or Kern.Card.Info on SummitStack) are not logged by default. You must configure

an EMS filter to log these messages, for example, configure `log filter DefaultFilter add event kern.info`. See the “[Status Monitoring and Statistics](#)” chapter for information about configuring EMS.

Metering Packets

The `meter <metername>` action modifier applies a meter to the traffic defined by an ACL. For more information, see “[Meters](#)” on page 739.

Mirroring Packets

You must enable port-mirroring on your switch. If you attempt to apply a policy that requires port-mirroring, you will receive an error message if port-mirroring is not enabled.

On the BlackDiamond X8 series switches, BlackDiamond 8000 c-, xl-, and xm-series modules and Summit X460, X480, X650, and X670 series switches, mirroring can be configured on the same port as egress ACLs. Mirroring can send packets to port x and you can install your rule at egress port x, and the rule should match your mirrored traffic.

Redirecting Packets

Packets are forwarded to the IPv4 address specified, without modifying the IP header (except the TTL is decremented and the IP checksum is updated). The IPv4 address must be in the IP ARP cache, otherwise the packet is forwarded normally. Only fast path traffic can be redirected. This capability can be used to implement Policy-Based Routing.

You may want to create a static ARP entry for the redirection IP address, so that there will always be a cache entry. See “[Policy-Based Routing](#)” on page 706 for more information.

Replacing DSCP or 802.1p Fields

Specify a QoS profile for matching packets. The field values are replaced with the value associated with that profile. In the following example, DiffServ replacement is configured such that QP8 is mapped to code point 56. Matching packets are sent to QP8, and the DSCP value in the packet is set to 56.

```
entry voice_entry {
  if {
    source-address 2.2.2.2/32;
  } then {
    qosprofile qp8;
    replace-dscp;
  }
}
```

See [Chapter 20, “QoS,”](#) for more details about QoS profiles, and 802.1p and DSCP replacement.

ACL Rule Syntax Details

[Table 70](#) lists the match conditions that can be used with ACLs, and whether the condition can be used for ingress ACLs only, or with both ingress and egress. The conditions are case-insensitive; for example, the match condition listed in the table as `TCP-flags` can also be written as `tcp-flags`. Within [Table 70](#) are five different data types used in matching packets. [Table 71](#) lists the data types and details on using them. [Table 72](#) lists the match conditions that apply only to VMAN traffic.

Table 70: ACL Match Conditions

Match Conditions	Description	Applicable IP Protocols/ Direction
ethernet-type <number>	Ethernet packet type. In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed): ETHER-P-IP (0x0800), ETHER-P-8021Q (0x8100), ETHER-P-IPV6 (0x86DD) ^a .	Ethernet/ Ingress and Egress
ethernet-source-address <mac-address>	Ethernet source MAC address	Ethernet/ Ingress and Egress
ethernet-source-address <mac-address> mask <mask> or ethernet-source-address <mac-address> / <mask>	<p>Ethernet source MAC address and mask. The mask is optional, and is in the same format as the MAC address, for example:</p> <pre>ethernet-source-address 00:01:02:03:01:01 mask ff:ff:ff:ff:00:00</pre> <p>or</p> <pre>ethernet-source-address 00:01:02:03:01:01 / ff:ff:ff:ff:00:00</pre> <p>Only those bits of the MAC address whose corresponding bit in the mask is set to 1 will be used as match criteria. So, the example above will match 00:01:02:03:xx:xx.</p> <p>If the mask is not supplied then it will be assumed to be ff:ff:ff:ff:ff:ff. In other words, all bits of the MAC address will be used for matching.</p>	Ethernet/ Ingress and Egress
ethernet-destination- address <mac-address>	Ethernet destination MAC address	Ethernet/ Ingress and Egress
ethernet-destination- address <mac-address> mask <mask> or ethernet-destination- address <mac-address> / <mask>	<p>Ethernet destination MAC address and mask. The mask is optional, and is in the same format as the MAC address, for example:</p> <pre>ethernet-destination-address 00:01:02:03:01:01 mask ff:ff:ff:ff:00:00</pre> <p>or</p> <pre>ethernet-destination-address 00:01:02:03:01:01 / ff:ff:ff:ff:00:00</pre> <p>Only those bits of the MAC address whose corresponding bit in the mask is set to 1 will be used as match criteria. So, the example above will match 00:01:02:03:xx:xx.</p> <p>If the mask is not supplied then it will be assumed to be ff:ff:ff:ff:ff:ff. In other words, all bits of the MAC address will be used for matching.</p>	Ethernet/ Ingress and Egress
source-address <prefix>	<p>IP source address and mask. Use either all IPv4 or all IPv6 addresses in an ACL.</p> <p>On BD8K, BDX8 and Summit series switches, using arbitrary mask arguments is supported. Masks are not restricted to be of a subnet type. Examples of arbitrary IPv4 and IPv6 masks include 10.22.3.4 and 1:0:0:fff:2:4. The 1s in the mask indicate the corresponding bits of the source-address that should be used as part of the match criteria.</p>	All IP/Ingress and Egress

Table 70: ACL Match Conditions (Continued)

Match Conditions	Description	Applicable IP Protocols/ Direction
destination-address <prefix>	<p>IP destination address and mask. Egress ACLs do not support IPv6 addresses, only IPv4 addresses. Use either all IPv4 or all IPv6 addresses in an ACL.</p> <p>On BD8K, BDX8 and Summit series switches, using arbitrary mask arguments is supported. Masks are not restricted to be of a subnet type. Examples of arbitrary IPv4 and IPv6 masks include 10.22.3.4 and 1:0:0:fff:2:4. The 1s in the mask indicate the corresponding bits of the destination-address that should be used as part of the match criteria.</p>	All IP/Ingress and Egress
Source-port {<number> <range>}	<p>TCP or UDP source port. You must also specify the protocol match condition to determine which protocol is being used on the port, any time you use the this match condition. In place of the numeric value, you can specify one of the text synonyms listed under destination port. If no source-port is specified, the default source-port is "any."</p>	TCP, UDP/ Ingress and Egress
Destination-port {<number> <range>}	<p>TCP or UDP destination port. You must also specify the protocol match condition to determine which protocol is being used on the port, any time you use the this match condition. In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed):</p> <p>afs(1483), bgp(179), biff(512), bootpc(68), bootps(67), cmd(514), cvspserver(2401), DHCP(67), domain(53), eklogin(2105), ekshell(2106), exec(512), finger(79), ftp(21), ftp-data(20), http(80), https(443), ident(113), imap(143), kerberos-sec(88), klogin(543), kpasswd(761), krb-prop(754), krbupdate(760), kshell(544), idap(389), login(513), mobileip-agent(434), mobileip-mn(435), msdp(639), netbios-dgm(138), netbios-ns(137), netbios-ssn(139), nfsd(2049), nntp(119), ntalk(518), ntp(123), pop3(110), pptp(1723), printer(515), radacct(1813), radius(1812), rip(520), rkinit(2108), smtp(25), snmp(161), snmptrap(162), snpp(444), socks(1080), ssh(22), sunrpc(111), syslog(514), tacacs-ds(65), talk(517), telnet(23), tftp(69), timed(525), who(513), xdmcp(177), zephyr-ctl(2103), or zephyr-hm(2104).</p>	TCP, UDP/ Ingress and Egress
TCP-flags <bitfield>	<p>TCP flags. Normally, you specify this match in conjunction with the protocol match statement. In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed): ACK(0x10), FIN(0x01), PUSH(0x08), RST(0x04), SYN(0x02), URG(0x20), SYN_ACK(0x12).</p>	TCP/Ingress and Egress
IGMP-msg-type <number>	<p>IGMP message type. Possible values and text synonyms: v1-report(0x12), v2-report(0x16), v3-report(0x22), V2-leave (0x17), or query(0x11).</p>	IGMP/Ingress only
ICMP-type <number>	<p>ICMP type field. Normally, you specify this match in conjunction with the protocol match statement. In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed): echo-reply(0), echo-request(8), info-reply(16), info-request(15), mask-request(17), mask-reply(18), parameter-problem(12), redirect(5), router-advertisement(9), router-solicit(10), source-quench(4), time-exceeded(11), timestamp(13), timestamp-reply(14), or unreachable(3).</p>	ICMP/Ingress only

Table 70: ACL Match Conditions (Continued)

Match Conditions	Description	Applicable IP Protocols/ Direction
ICMP-code <number>	<p>ICMP code field. This value or keyword provides more specific information than the icmp-type. Because the value's meaning depends upon the associated icmp-type, you must specify the icmp-type along with the icmp-code (only available in IPv4). In place of the numeric value, you can specify one of the following text synonyms (the field values also listed); the keywords are grouped by the ICMP type with which they are associated:</p> <p>Parameter-problem: ip-header-bad(0), required-option-missing(1)</p> <p>Redirect: redirect-for-host (1), redirect-for-network (2), redirect-for-tos-and-host (3), redirect-for-tos-and-net (2)</p> <p>Time-exceeded: ttl-eq-zero-during-reassembly(1), ttl-eq-zero-during-transit(0)</p> <p>Unreachable: communication-prohibited-by-filtering(13), destination-host-prohibited(10), destination-host-unknown(7), destination-network-prohibited(9), destination-network-unknown(6), fragmentation-needed(4), host-precedence-violation(14), host-unreachable(1), host-unreachable-for-TOS(12), network-unreachable(0), network-unreachable-for-TOS(11), port-unreachable(3), precedence-cutoff-in-effect(15), protocol-unreachable(2), source-host-isolated(8), source-route-failed(5)</p>	IPv4 only/ ICMP/Ingress only
source-sap	<p>SSAP is a 1 byte field with possible values 0-255 decimal. The value can be specified in decimal or hexadecimal. The SSAP field can be found at byte offset 15 in 802.3 SNAP and LLC formatted packets. (Available on Summit family switches, SummitStack, and BlackDiamond 8000 c-, e-, xl-, and xm-series modules only.)</p>	Ethernet/ Ingress Only
destination-sap	<p>DSAP is a 1 byte field with possible values 0-255 decimal. The value can be specified in decimal or hexadecimal. The DSAP field can be found at byte offset 14 in 802.3 SNAP and LLC formatted packets. (Available on Summit family switches, SummitStack, and BlackDiamond 8000 c-, e-, xl-, and xm-series modules only.)</p>	Ethernet/ Ingress Only
snap-type	<p>SNAP type is a 2 byte field with possible values 0-65535 decimal. The value can be specified in decimal or hexadecimal. The SNAP type field can be found a byte offset 20 in 802.3 SNAP formatted packets. (Available on Summit family switches, SummitStack, and BlackDiamond 8000 c-, e-, xl-, and xm-series modules only.)</p>	Ethernet/ Ingress Only
IP-TOS <number>	<p>IP TOS field. In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed): minimize-delay 16 (0x10), maximize-reliability 4(0x04), minimize-cost2 (0x02), and normal-service 0(0x00).</p>	All IP/Ingress and Egress
dscp <value>	<p>DSCP field. In place of the value, you can specify one of the DSCP numeric values (for example, 8, 16, or 24).</p>	All IP/Ingress and Egress

Table 70: ACL Match Conditions (Continued)

Match Conditions	Description	Applicable IP Protocols/ Direction
fragments	BlackDiamond X8 series switches, BlackDiamond 8000 c-, e-, xl-, and xm-series modules, and Summit family switches only—IP fragmented packet. FO > 0 (FO = Fragment Offset in IP header) ^b	All IP, no L4 rules/Ingress only
first-fragment	Non-IP fragmented packet or first fragmented packet. FO==0.	All IP/Ingress only
protocol <number>	IP protocol field. For IPv6 ^c , this matches the Next Header field in the packet. In place of the numeric value, you can specify one of the following text synonyms (the field values are also listed): egp(8), gre(47), icmp(1), igmp(2), ipip(4), ipv6 over ipv4(41), ospf(89), pim(103), rsvp(46), st(5), tcp(6), or udp(17).	All IP/Ingress and Egress
vlan-id <number>	Matches the VLAN tag number or the VLAN ID which is given to a VLAN when created. The ACL rule can only be applied to ports or any, and not VLANs. The following restriction applies to all platforms: <ul style="list-style-type: none"> The vlan-id match condition matches on the “outer” tag of a VMAN. The vlan-id ACL keyword can be used in egress ACL. 	Ethernet/ Ingress and Egress
dot1p <priority tag>	Creates an ACL with 802.1p match conditions, allowing the ACL to take action based on the VLAN tag priority. (Available on all platforms.)	All IP/Ingress
arp-sender-address <prefix>	Matches the ARP sender protocol address and target protocol address respectively. <prefix> => <IPv4 address> / <mask length>.	ARP packets/ Ingress
and	They cannot be combined with an Ethernet-source-address or Ethernet-destination-address in the same rule.	
arp-target-address <prefix>	They can be used only when the ACL hardware database is configured to be internal for those platforms that support “external-table” ACL databases. (for example, Summit X480 switches and BlackDiamond 8900 xl-series modules). (Available on BlackDiamond X8 series switches, BlackDiamond 8800 switches and Summit family switches only.)	

a. However, packets using the Ethernet type for VMANs, 0x88a8 by default, are handled by VMAN ACLs.

b. See the section “[Fragmented packet handling](#)” for details.

c. See the section “[IPv6 Traffic with L4 Match Conditions](#)” for details about specifying a protocol/port match with IPv6.

**NOTE**

When you use a configured ACL that contains a match condition with any <mac-address>, IGMP snooping stops working and IGMP joins are flooded to all ports in a VLAN. When you unconfigure the ACL, IGMP joins stop flooding.

**NOTE**

An ACL that matches the EAPS `ethernet-destination-address (00:e0:2b:00:00:04)` or `ethernet-source-address (00:e0:2b:00:00:01)` match condition with the `permit` action should not be applied to an EAPS master node on EAPS ring ports. Doing so causes an EAPS PDU loop. For the EAPS master node, you should use the `copy-cpu-and-drop` action with either of these match conditions. For an EAPS transit

node, use the `permit` action with either of these match conditions. This applies only to BlackDiamond 8000 series modules and Summit switches.

**NOTE**

Directed ARP response packets cannot be blocked with ACLs from reaching the CPU and being learned on BlackDiamond X8 series switches, BlackDiamond 8000 c-, e-, xl-, and xm-series modules and the Summit family switches.

Along with the data types described in [Table 71](#), you can use the operators `<`, `<=`, `>`, and `>=` to specify match conditions. For example, the match condition, `source-port > 190`, will match packets with a source port greater than 190. Be sure to use a space before and after an operator.

Table 71: ACL Match Condition Data Types

Condition Data Type	Description
prefix	IP source and destination address prefixes. To specify the address prefix, use the notation <code>prefix/prefix-length</code> . For a host address, <code>prefix-length</code> should be set to 32.
number	Numeric value, such as TCP or UDP source and destination port number, IP protocol number.
range	A range of numeric values. To specify the numeric range, use the notation: <code>number - number</code>
bit-field	Used to match specific bits in an IP packet, such as TCP flags and the fragment flag.
mac-address	6-byte hardware address.

IPv6 Traffic with L4 Match Conditions

If you apply an ACL policy intended to match IPv6 packets using an ACL that specifies L4 conditions, the traffic will not be matched. For example, the following ACL will not match any IPv6 packets:

```
entry destIp {
  if {
    protocol tcp;
    destination-port 120 - 150;
  }
  then {
    permit;
    count destIp;
  }
}
```

Fragmented packet handling

Two keywords are used to support fragmentation in ACLs:

- `fragments`—FO field `> 0` (FO means the fragment offset field in the IP header.)—BlackDiamond X8 series switches, BlackDiamond 8000 c-, e-, xl-, and xm-series modules, and Summit family switches only.
- `first-fragments`—FO `== 0`.

Policy file syntax checker. The `fragments` keyword cannot be used in a rule with L4 information. The syntax checker will reject such policy files.

The following rules are used to evaluate fragmented packets or rules that use the `fragments` or `first-fragments` keywords.

With no keyword specified, processing proceeds as follows:

- An L3-only rule that does not contain either the `fragments` or `first-fragments` keyword matches any IP packets.
- An L4 rule that does not contain either the `fragments` or `first-fragments` keyword matches non-fragmented or initial-fragment packets.

With the `fragments` keyword specified:

- An L3-only rule with the `fragments` keyword only matches fragmented packets.
- An L4 rule with the `fragments` keyword is not valid (see above).

With the `first-fragments` keyword specified:

- An L3-only rule with the `first-fragments` keyword matches non-fragmented or initial fragment packets.
- An L4 rule with the `first-fragments` keyword matches non-fragmented or initial fragment packets.

Wide Key ACLs

BlackDiamond X8 Series Switches, BlackDiamond 8000 c-, xl-, and xm-series modules and Summit X460, X480, X650, and X670 switches. This feature allows the use of a 362-bit double wide match key instead of a standard 181-bit single wide key to be used with match conditions. A double wide match key allows you to add more match conditions to an ACL. It also allows matching on a full destination-source IPv6 address.

The feature does not add any new match conditions but rather allows you to add additional condition combinations to any single wide condition combination that is already supported. The existing supported condition combinations are described in [Table 74](#) through [Table 79](#). The double wide condition combinations that can be appended under the set union operation to the single wide condition combinations are as follows:

- OVID, DIP, SIP, IpInfo(First-Fragment,Fragments), IP-Proto, DSCP, TCP-Flag, L4SP, L4DP
- SIPv6, IP-Proto, DSCP, TCP-Flag, L4SP, L4DP

For example, your single wide mode supports condition combination A, B, and C, and the double wide mode adds condition combinations D1 and D2. Then in a single wide mode, the conditions of your rule should be a subset of either {A}, or {B}, or {C} and in a double wide mode, the conditions of your rule should be a subset of either {A ∪ D1}, or {A ∪ D2}, or {B ∪ D1}, or {B ∪ D2}, or {C ∪ D1}, or {C ∪ D2}.

The platforms that support this feature can operate either in double wide mode or in the current single wide mode. A individual switch or module cannot be configured to operate in a mixed double and single wide mode. However a BlackDiamond 8800 chassis or a SummitStack can have a mixture of modules and switches with some of them operating in a single wide mode and some in a double wide mode.

Limitations. Following are limitations associated with this feature:

- Double wide mode provides richer condition combinations. However, when in a double wide mode, you can install only one half as many rules into the internal ACL TCAM as you can when in a single wide mode.
- Double wide mode is supported only by internal TCAM hardware. External TCAM hardware does not support this feature and thus, is not applicable to external TCAM ACLs.
- Only ingress ACLs support this feature. Egress and external ACLs do not support it.
- BlackDiamond 8000 10G24Xc2 and 10G24Xc modules and Summit X650 switches can operate in double wide mode only in slices 8, 9, 10, and 11. Therefore, when you configure double wide mode on these platforms, they operate in double mode on slices 8 through 11 and in single mode on slices 0 through 7.

Configuring Wide Key ACL Modes. To configure the TCAM width of a slot, switch in a SummitStack or stand-alone switch, use the following command:

```
configure access-list width [double | single] [slot <slotNo | all>]
```

You must reboot for the configuration to take effect.

If you attempt to configure a double wide mode on a slot or switch that does not support it, an error message is displayed.

When switching from single wide key mode to double wide key mode and rebooting, the following conditions apply:

- Configurations that have less than one-half the number of ACL rules that the single wide key mode supports, reboot successfully.
- Configurations that have more than one-half the number of ACL rules that the single wide key mode supports, fail after the reboot.

When switching from double wide key mode to single wide key mode and rebooting, the following conditions apply:

- Configurations that do not use the additional condition combinations that double wide key mode offers, reboot successfully.
- Configurations that use the additional condition combinations that the double wide key mode offers, fail after the reboot.

To display the wide key mode settings, use the following command:

```
show access-list width [slot <slotNo | all>]
```

Layer-2 Protocol Tunneling ACLs

Three ACL match conditions and one ACL action interoperate with vendor-proprietary Layer-2 protocol tunneling on the platforms listed for this feature in [Appendix A, “Feature License Requirements.”](#)

The following fields within 802.3 Subnetwork Access Protocol (SNAP) and LLC formatted packets can be matched:

- Destination service access point (SAP)
- Source SAP

The following field can be matched within Subnetwork Access Protocol (SNAP) packets only:

- SNAP type

The following ACL action is added to the specified switches:

- Replacement of the Ethernet MAC destination address

This action replaces the destination MAC address of any matching Layer-2 forwarded packets on the supported platforms. This action can be used to effectively tunnel protocol packets, such as STP, across a network by replacing the well-known protocol MAC address with a different proprietary or otherwise unique MAC address. After tunnel egress, the MAC destination address can be reverted back to the well-known MAC address.



NOTE

The “replace-ethernet-destination-address” action applies only to Layer-2 forwarded packets.

ACL Byte Counters

An ACL byte counter associated with a particular rule, either dynamic or static, shows how many bytes of traffic have matched that ACL rule. You can use ACL byte counters as an alternative to packet counters on the platforms listed for this feature in [Appendix A, “Feature License Requirements.”](#)

A new ACL action token has been added to associate a byte counter with an ACL, and a new corresponding token for a packet counter. Following are the two new tokens:

```
byte-count <byte counter name>
packet-count <packet counter name>
```

An ACL rule specifying both packet and byte counter is rejected.

Following is an example of an ACL rule that uses a byte counter:

```
entry CountBytes {
  if {
    ethernet-source-address 00:aa:00:00:00:10;
  } then {
    byte-count CountBytes;
    permit;
  }
}
```

Following are two examples of ACL rules that use packet counters. The “packet-count” token is a synonym of the existing “count” token.

```
entry CountPacket1 {
  if {
    ethernet-source-address 00:aa:00:00:00:10;
  } then {
    count CountPacket1;
    permit;
  }
}
```

```

entry CountPacket2 {
  if {
    ethernet-source-address 00:aa:00:00:00:10;
  } then {
    packet-count CountPacket2;
    permit;
  }
}

```

The output of the `show access-list counter` and `show access-list dynamic counter` commands has been changed to include a new “Byte Count” column in addition to the “Packet Count” column. When a rule utilizes a byte counter, the “Byte Count” field is incremented and the “Packet Count” field stays at zero. If a rule utilizes a packet counter, the “Packet Count” field is incremented and the “Byte Count” field stays at zero.

**NOTE**

Byte counters and packet counters cannot be used at the same time in the same rule.

Dynamic ACLs

Dynamic ACLs are created using the CLI. They use a similar syntax and can accomplish the same actions as single rule entries used in ACL policy files. More than one dynamic ACL can be applied to an interface, and the precedence among the dynamic ACLs can be configured. By default, the priority among dynamic ACLs is established by the order in which they are configured.

**NOTE**

Dynamic ACLs have a higher precedence than ACLs applied using a policy file.

The steps involved in using a dynamic ACL on an interface are:

- [Creating the Dynamic ACL Rule on page 671](#)
- [Configuring the ACL Rule on the Interface on page 672.](#)
- [Configuring ACL Priority on page 673](#)
- [Network-Zone Support in ACLs on page 677](#)

Creating the Dynamic ACL Rule

Creating a dynamic ACL rule is similar to creating an ACL policy file rule entry. You specify the name of the dynamic ACL rule, the match conditions, and the actions and action-modifiers. You can configure a dynamic ACL to be persistent or non-persistent across system reboots. User-created access-list names are not case sensitive. The match conditions, actions, and action-modifiers are the same as those that are available for ACL policy files (see [“ACL Rule Syntax” on page 656](#)). In contrast to the ACL policy file entries, dynamic ACLs are created directly in the CLI. Use the following command to create a dynamic ACL:

```
create access-list <dynamic-rule> <conditions> <actions> {non-permanent}
```

As an example of creating a dynamic ACL rule, compare an ACL policy file entry with the CLI command that creates the equivalent dynamic ACL rule. The following ACL policy file entry will drop all ICMP echo-requests:

```
entry icmp-echo {
  if {
    protocol icmp;
    icmp-type echo-request;
  } then {
    deny;
  }
}
```

To create the equivalent dynamic ACL rule, use the following command:

```
create access-list icmp-echo "protocol icmp;icmp-type echo-request" "deny"
```

Notice that the `conditions` parameter is a quoted string that corresponds to the match conditions in the `if { ... }` portion of the ACL policy file entry. The individual match conditions are concatenated into a single string. The `actions` parameter corresponds to the `then { ... }` portion of the ACL policy file entry.

From the command line, you can get a list of match conditions and actions by using the following command:

```
check policy attribute {<attr>}
```

The ACL rule shown in the example will be saved when the `save` command is executed, because the optional keyword `non-permanent` was not configured. This allows the rule to persist across system reboots.

Note also that the sample ACL rule does not specify an application to which the rule belongs. The default application is CLI.

Limitations. Dynamic ACL rule names must be unique, but can be the same as used in a policy file-based ACL. Any dynamic rule counter names must be unique. CLEAR-Flow rules can be specified only in policy files and therefore apply only to rules created in a policy file.

Configuring the ACL Rule on the Interface

After a dynamic ACL rule has been created, it can be applied to a port, VLAN, or to the wildcard `any` interface. When the ACL is applied, you specify the precedence of the rule among the dynamic ACL rules. To configure the dynamic ACL rule on an interface, use the following command:

```
configure access-list add <dynamic_rule> [ [[first | last] {priority <p_number>} {zone <zone>} ] | [[before | after] <rule>] | [ priority <p_number> {zone <zone>} ]] [ any | vlan <vlaname> | ports <portlist> ] {ingress | egress}
```

To remove a dynamic ACL from an interface, use the following command:

```
configure access-list delete <ruleName> [ any | vlan <vlaname> | ports <portlist> | all] {ingress | egress}
```

An ACL can be created to be used when an edge port detects a loop. This ACL acts to block looped frames while allowing the port to remain in a forwarding state rather than shutting down. To configure a dynamic ACL for blocking looped STP BPDUs on port 6, for example, use the following:

```
create access-list bpdul "ethernet-destination-address \
    01:80:C2:00:00:00;" "deny; count bpdul"
```

```
conf access-list add "bpdu1" first ports 6 ingress
```

To configure a dynamic ACL for blocking PVST frames on port 6, use the following:

```
create access-list bpdu2 "ethernet-destination-address \
    01:00:0c:cc:cc:cd;" "deny; count bpdu2"
```

```
conf access-list add "bpdu2" first ports 6 ingress
```

To unconfigure the STP ACL, use the following:

```
conf access-list del "bpdu1" ports 6
del access-list "bpdu1"
```

Configuring ACLs on a Management Port

Hardware ACL support is not possible on the management port. Untagged packets that are received on the management port are processed in software and can be filtered using ACLs. ACLs applied to the management port/vlan are installed only in software and not in the hardware.

For example, to block an ICMP echo-request on a management port, use the following:

```
create access-list echo "protocol icmp; icmp-type echo-request;" "deny; count echo"
conf access-list add "echo" first vlan "Mgmt" ingress
```

To unblock ICMP echo-request on a management port, use the following:

```
conf access-list del "echo" vlan "Mgmt"
del access-list "echo"
```

To show ACL dropped packet counters, use the following command:

```
show access-list dynamic counter
```

Configuring ACL Priority

Management of ACLs is flexible, with configurable priority for dynamic ACLs. This includes ACLs inserted by internal and external applications, as well as those inserted using the CLI. The priority is assigned by a system of zones, and within zones by numeric codes.

Zones are of two types:

- System Space—The System Space zones include the following:
 - SYSTEM_HIGH—This zone always has the highest priority.
 - SYSTEM_LOW—This zone always has the lowest priority.

The priorities cannot be changed.

No configuration is allowed by the user into System Space.

Hal is the only application in a System Space zone.
- User Space—The User Space zones include the following:
 - DOS—This is the denial of service zone.
 - SYSTEM—This is the zone for applications that require a CPU-copy or mirror and for redirect ACLs.
 - SECURITY—This is the zone for ACLs installed by security appliances and internal security processes.

User Space zones consist of default zones and created zones. Default zones group like functions and cannot be deleted.

The administrator has the ability to create new zones and configure the priority of both default and created zones. See “[Configuring User Zones](#)” on page 674 for discussion of created zones and applications. Applications insert ACLs into zones.

To view both System Space and User Space zones, use the `show access-list zone` command.

[Table 72](#) shows the priority of System Space zones and User Space zones together with the default assignments and priority of applications by zone.

Table 72: Default Assignment and Priority of Applications, by Zone

Zone/Default Application	Default Priority	Platform
SYSTEM SPACE ZONES		
hal	1	
USER SPACE ZONES		
DOS	2	
hal	1	All platforms
Dos	2	All platforms
SYSTEM	3	
Cli	1	All platforms
IpSecurity	2	All platforms
NetLogin	6	All platforms
SECURITY	4	
Sentriant	1	All platforms
GenericXml (Allows configuration of one additional external application)	4	All platforms
SYSTEM SPACE ZONES		
hal	1	



NOTE

The priority of static ACLs is determined by the order they are configured, with the first rule configured having the highest priority.

Configuring User Zones

There is a configurable process for applications to insert an ACL into a zone according to the priority of the application within that zone. Applications can occupy multiple zones. For example, you can add the Cli application to the DOS zone, and assign it a higher priority than the Dos application. The DOS zone then has two applications, Cli and Dos application, and within the DOS zone, an ACL created by the Cli has a higher priority than an ACL inserted by the Dos application.

Another way to configure ACL priority is by creating new zones. For example, you might create a zone called MY_HIGH_ZONE, and assign that zone a priority below the DOS zone and above the System zone. You can add applications to that zone and assign their priority. The example below shows the

ACL zone priority that would result from adding the MacInMac and Cli applications to MY_HIGH_ZONE:

- 1 SYSTEM_HIGH_ZONE
 - hal
- 2 DOS Zone
 - hal
 - DoS
- 3 MY_HIGH_ZONE
 - MacInMac
 - Cli
- 4 SYSTEM Zone
 - Dot1Ag
 - Dot1AgDefault
 - MacInMac
 - Cli
 - NetLogin
- 5 SECURITY Zone
 - Sentriant
 - FlowVSR
 - FlowVSRTS
 - Generic Xml
- 6 SYSTEM_LOW_ZONE
 - hal

Applications can insert an ACL into any of the zones to which the application belongs. If an application attempts to insert an ACL into a zone where the application is not configured, an error message appears, and the ACL is not installed. Therefore, you have full control of ACL priorities and you can configure the switch to install ACLs from an application at any priority level. In the example above, the application Cli can insert an ACL into either MY_HIGH_ZONE or the SYSTEM zone. The location of the ACL within the zone depends on the priority assigned by the application. An application can assign priority to an ACL using:

- priority attributes (first or last)
- relative priority
- priority numbers

The priority attributes *first* (highest priority) and *last* (lowest priority) can be applied to an ACL to establish its position within a zone.

Relative priority sets the ACL priority relative to another ACL already installed by the application in the same zone.

Priority numbers allow an application to specify the priority of an ACL within a zone. The priority numbers are unsigned integers from 0 to 7; a lower number represents a higher priority. This means that if an application adds an ACL at priority 5 and later adds another ACL at priority 3, the second ACL has higher priority.

If an application assigns the same priority number to two ACLs, the ACL added most recently has the higher priority. It is inserted in the priority map immediately ahead of the older ACL that has the same priority number. This effectively allows the application to create sub-zones within a zone. The attributes *first* and *last* can be used in combination with priority numbers to prioritize the ACLs within a sub-

zone. For example, an ACL could be configured with the *first* attribute, along with the same priority number as other ACLs in the same zone, effectively assigning that ACL the highest priority within a sub-zone.

The `show configuration` command shows the current configuration of the entire switch in the form of CLI commands which can later be played back to configure the switch.

The `show configuration acl` command shows the current configuration of the ACL manager.

The new `application` keyword allows you to specify the application to which the ACL will be bound. Typically, applications create and insert ACLs on the switch; however the administrator can install ACLs "on behalf" of an application by specifying the `application` keyword. (This keyword is also used with the `show config acl` command to enable CLI playback). If no application is specified, the default application is CLI.

This means you have the ability to create, delete, and configure ACLs for any application.

To create a zone, use the following command:

```
create access-list zone <name> zone-priority <number>
```

To configure the priority of zones, use the following command:

```
configure access-list zone <name> zone-priority <number>
```

To add an application to a zone at a particular priority, or to change the priority of an application within a zone, use the following command:

```
configure access-list zone <name> {add} application <appl-name> application_priority <number>
```

An application must occupy at least one zone.

To move an application within a zone or to another zone use the following command:

```
configure access-list zone <name> move-application <appl-name> to-zone <name> application-priority <number>
```

All applications can be configured to go into any and all zones.

A change in the zone list results in a change in the order of dynamic ACLs that have been applied per interface. The changes in hardware are achieved by uninstalling and then reinstalling the dynamic ACLs in the new positions. There is a possibility, due to hardware constraints, that some ACLs will not be reinstalled. These occurrences are logged.

To delete an application from a zone, use the following command:

```
configure access-list zone <name> delete application <appl-name>
```

When deleting an application from a zone, any ACLs that have been inserted into that zone for the deleted application are moved to the next higher zone in which the application appears.

To delete a zone use the following command:

```
delete access-list zone <name>
```

You must remove all applications from a zone before you can delete the zone. You cannot delete the default zones.

Network-Zone Support in ACLs

ExtremeXOS Network-Zone support allows you to create a network-zone, add multiple IP addresses and/or MAC addresses to it, and use the network zone in policy files.

This feature provides the ability to add a single attribute “source-zone”, or “destination-zone” to an entry of a policy file. This entry is then expanded into multiple entries depending upon the number of IP and/or MAC addresses configured in that particular zone. If the zone is added to the policy with the keyword “source-zone”, the attributes that are configured in that particular zone are added as either a “source-address” or an “ethernet-source-address” in the policy. Conversely, if the network-zone is added as a “destination-zone”, the attributes are added to the policies as a “destination-address”, or an “ethernet-destination-address”.

After you make changes in the zones and issue a refresh of a specific zone, or all the zones, the policies that have the corresponding zones configured as source-zone or destination-zone in their entries, are expanded and refreshed in the hardware.

Here is an example:

If you configure the following policy to a port or VLAN, or through applications like IdMgr or XNV,

```
Policy: test
entry e1 {
if match all {
    source-zone zone1 ;
}
then {
    permit ;
}
}
```

and the network-zone “zone1” that is part of the policy is configured as below:

```
create access-list network-zone zone1
configure access-list network-zone zone1 add ipaddress 10.1.1.1 255.255.255.255
configure access-list network-zone zone1 add ipaddress 10.1.1.1 255.255.255.240
configure access-list network-zone zone1 add ipaddress 12.1.1.0 255.255.255.0
```

When you refresh the network-zone “zone1”, the policy is expanded as follows, and is applied in the hardware:

```
entry C10:0_10.1.1.1_E1 {
    if match all {
        source-address 10.1.1.1 / 32 ;
    } then {
        permit ;
    }
}

entry C10:0_10.1.1.1_E2 {
    if match all {
        source-address 10.1.1.1 / 28 ;
    } then {
        permit ;
    }
}

entry C10:0_12.1.1.0_E3 {
    if match all {
```

```
    source-address 12.1.1.0 / 24 ;
  } then {
    permit ;
  }
}
```

When the policy is configured with the network-zone, the zone may, or may not, have attributes configured in it. In cases where the network-zone does not have any attributes, the policy is created with entries that do not have the network-zone attribute alone.

So, if you create the following policy:

```
Policy: test2
entry e1 {
if match all {
    source-zone zone2 ;
    protocol udp ;
}
then {
    permit ;
}
}
entry e2 {
if match all {
    protocol tcp ;
}
then {
    permit ;
}
}
```

And the network-zone “zone2” is just created, but is not configured with any attributes, the policy appears as follows and has only the second entry “e2”, and not “e1”.

```
entry e2 {
protocol tcp;
}
then {
    permit;
}
}
```

Once the network-zone “zone2” is configured with one or more attributes, and refreshed, the policy is updated accordingly. In this instance, the name of the entries that have a source-zone or a destination-zone are changed. This is because each entry in the original policy that has a source-zone/destination-zone is converted to a maximum of eight entries in the new policy.

A single policy can have one or more network-zones configured in it. It can also have the same network-zone in multiple entries with different combinations, as well as support for other attributes in the policy file. Similarly, the same network-zone can be configured to multiple policies. In cases where the policy has multiple network-zones, and only some of those network-zones are refreshed, the entries that correspond to those specific network-zones are alone refreshed, and not entries that correspond to the other network zones.

After you refresh a network zone, all the policies that have the specified network zone are modified, and a refresh for each of those policies is sent to the hardware. The command succeeds only after receiving a successful return for all the policies that have this particular network zone. If for some reason one of the policy's refresh fails in the hardware, all the policies that are supposed to refresh are reverted back to their previous successful state, and the command is rejected.

Additionally, the configuration or refresh can fail if the attributes in the network zone are not compatible with the attributes in the corresponding entries of the policy. For example, in platforms that do not support wide-key or UDF, a policy entry cannot have Layer2 attributes and Layer4 attributes. In such cases, if the entry has "protocol tcp" and a network zone that has an ethernet source address, the configuration fails in the hardware.

In cases where the refresh fails, the content of the policy and the content of the network-zone may go out of sync, because the policy reverts back to the last successful state, whereas the network-zone will contain the last configured values.

Here is an example:

```
create access-list network-zone zone1
configure access-list network-zone zone1 add ipaddress 10.1.1.1/32
configure access-list network-zone zone1 add ipaddress 10.1.1.1/28
```

Once this configuration is refreshed and is successfully installed in the hardware, the policy will look like the following:

```
entry C10:0_10.1.1.1_E1 {
  if match all {
    source-address 10.1.1.1 / 32 ;
  } then {
    permit ;
  }
}

entry C10:0_10.1.1.1_E2 {
  if match all {
    source-address 10.1.1.1 / 28 ;
  } then {
    permit ;
  }
}
```

If you remove 10.1.1.1/28, and adds 10.1.1.1/24 to the network zone and perform a refresh,

```
configure access-list network-zone zone1 delete ipaddress 10.1.1.1/28
configure access-list network-zone zone1 add ipaddress 12.1.1.0/24
```

and if for some reason the policy refresh fails, the policy and the network-zone will look like this:

```
entry C10:0_10.1.1.1_E1 {
  if match all {
    source-address 10.1.1.1 / 32 ;
  } then {
    permit ;
  }
}
```

```
entry C10:0_10.1.1.1_E2 {
  if match all {
    source-address 10.1.1.1 / 28 ;
  } then {
    permit ;
  }
}

create access-list network-zone zone1
configure access-list network-zone zone1 add ipaddress 10.1.1.1 255.255.255.255
configure access-list network-zone zone1 add ipaddress 12.1.1.0 255.255.255.0
```

Configuring Network-Zone Support in ACLs

Use the following commands to configure the Network-Zone support in ACLs:

Create a Network-Zone. To create a network-zone with the specified name, perform the following task. You can then associate this network-zone with the policy file using either the “source-zone”, or “destination-zone” attribute.

```
create access-list network-zone <zone_name>
```

Here is an example:

```
Switch# create access-list network-zone zone1
```

If you try to create a network-zone that is already created, the following error message is displayed on the console, and the command is rejected:

```
Switch#create access-list network-zone zone1
Error: Network Zone "zone1" already exists.
```

Delete a Network_Zone. To delete a network-zone, and all the configurations that belong to the zone, perform the following task:

```
delete access-list network-zone <zone_name>
```

Here is an example:

```
Switch# delete access-list network-zone zone1
```

If you try to delete a network-zone that is bound with one or more policy files, the following error message is displayed, and the command is rejected.

```
Switch # delete access-list network-zone zone1
Error: Network Zone "zone1" - Unable to delete zone. Zone has one
or more policies.
```

Adding or Removing Network_Zone Attributes. To add or remove IP/MAC addresses to or from the network-zone, perform the following task:

```
configure access-list network-zone <zone_name> [add | delete] [mac-address
<macaddress> {<macmask>} | ipaddress [<ipaddress> {<netmask>} | <ipNetmask> |
<ipv6_address_mask>]]
```

Here is an example:

```
Switch# configure access-list network-zone zone1 add ipaddress
11.1.1.1/24
```

If you try to add the same IP/MAC with the same or narrow mask, the configuration is rejected, with the following error message:

```
Switch #configure access-list network-zone "zone1" add ipaddress 11.1.1.1/32
Error: Network Zone "zone1" - Zone already has the same entity value with same or
wider mask.
```

If the you try to add more than eight attributes to a network-zone, the following error message is issued:

```
Switch #configure access-list network-zone "zone1" add ipaddress 11.1.1.1/24
Error: Network Zone "zone1" - Reached maximum number of attributes. Unable to add
more.
```

Refreshing Network Zones. To refresh a specific network zone, or all the network zones, perform the following task:

```
refresh access-list network-zone [<zone_name> | all]
```

Here is an example:

```
Switch # refresh access-list network-zone zone1
```



NOTE

When you issue the command to refresh a network-zone, or all network-zones, it can take a long time to clear the CLI because each individual policy must be converted before it is refreshed. The command succeeds, or fails, only after it receives a success response for all policy refresh, or when a first refresh failure is received from the hardware.

If the refresh fails for a specific zone, the following error message is printed on the console.

```
Switch # refresh access-list network-zone zone1
ERROR: Refresh failed for network-zone "zone1".
```

Monitoring Network-Zone Support in ACLs

Perform the following tasks to monitor various network statistics:

Show access-list network-zone. The `show access-list network-zone` command displays the network-zones configured, the number of attributes configured, and the number of policy files that has the specific zones in it.

```
show access-list network-zone
```

Example

```
Switch # sh access-list network-zone
=====
Network Zone                No. of    No. of Policies
```

```

                Entities      Bound
=====
zone1              5          2
zone2              3          1
zone3              0          0
=====
Total Network Zones : 3

```

The following example displays detailed information about a specific network zone, the attributes configured in the zone, and the policies bound to the zone:

```
show access-list network-zone <zone_name>
```

```
Switch #show access-list network-zone zone1
Network-zone      : zone1
Total Attributes  : 3
Attributes        : 10.1.1.1 / 32
                  : 10.1.1.1 / 30
                  : 10.1.1.0 / 24
No. of Policies   : 1
Policies          : test

```

```
Switch # sh access-list network-zone zone2
Network-zone      : zone2
No. of Entities   : 3
Entities          : 00:00:00:00:00:22 / ff:ff:ff:ff:ff:ff
                  : 00:00:00:00:00:23 / ff:ff:ff:ff:00:00
                  : 00:00:00:00:00:24 / ff:ff:ff:ff:ff:00
No. of Policies   : 0

```

ACL Evaluation Precedence

The following sections describe ACL evaluation precedence for different platforms:

- [Precedence for BlackDiamond X8 Series Switches, BlackDiamond 8800 Series Switches and Summit Family Switches on page 682](#)

Precedence for BlackDiamond X8 Series Switches, BlackDiamond 8800 Series Switches and Summit Family Switches

This section describes the precedence for evaluation among ACL rules for BlackDiamond X8 series switches, BlackDiamond 8800 series switches, SummitStack, and Summit family switches. In many cases there will be more than one ACL rule entry for an interface. This section describes how multiple rule entries are evaluated.

Multiple rule entries do consume hardware resources. If you find that your situation runs up against those limits, there are steps you can take to conserve resources by modifying the order of the ACL entries that you create. For details, see “[ACL Mechanisms](#).”

The section describes the following topics:

- [Rule Evaluation on page 683](#)
- [Precedence of Dynamic ACLs on page 683](#)
- [Precedence of L2/L3/L4 ACL Entries on page 683](#)
- [Precedence Among Interface Types on page 683](#)
- [Precedence with Egress ACLs on page 684](#)
- [Redundant Rules on page 684](#)

Rule Evaluation

When there are multiple rule entries applied to an interface, evaluation proceeds as follows:

- A packet is compared to all the rule entry match conditions at the same time.
- For each rule where the packet matches all the match conditions, the action and any action modifiers in the `then` statement are taken. If there are any actions or action modifiers that conflict (deny vs. permit, etc), only the one with higher precedence is taken.
- If a packet matches no rule entries in the ACL, it is permitted.

Often there will be a lowest-precedence rule entry that matches all packets. This entry will match any packets not otherwise processed, so that the user can specify an action to overwrite the default permit action. This lowest-precedence rule entry is usually the last entry in the ACL policy file applied to the interface.



NOTE

When a packet matches more than one rule entry, the highest precedence conflicting action is taken, so you can use the precedence to determine if a packet is permitted or denied. However, incrementing a counter is not a conflicting action, so a packet that matches more than one rule that increments a common counter, could count the packet more than once. Do not use precedence to control counter usage; define different counters for different cases. For details of this behavior on different platforms, see [“ACL Slices and Rules.”](#)

Precedence of Dynamic ACLs

Dynamic ACLs have a higher precedence than any ACLs applied using policy files. The precedence among any dynamic ACLs is determined as they are configured. The precedence of ACLs applied using policy files is determined by the rule's relative order in the policy file.

Precedence of L2/L3/L4 ACL Entries

Rule precedence is solely determined by the rule's relative order. L2, L3, and L4 rules are evaluated in the order found in the file or by dynamic ACL configuration.

Precedence Among Interface Types

As an example of precedence among interface types, suppose a physical port 1:2 is a member port of the VLAN *yellow*. ACLs could be configured on the port, either singly or as part of a port list, on the VLAN *yellow*, and on all ports in the switch (the wildcard ACL). For all packets crossing this port, the port-based ACL has highest precedence, followed by the VLAN-based ACL and then the wildcard ACL.

Precedence with Egress ACLs

Egress ACLs are supported on the BlackDiamond X8 series switches, BlackDiamond 8000 c-, xl-, and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit X460, X480, X650, and X670 series switches. For these, egress ACL lookup happens at egress, and diffserv, dot1p and other non-ACL feature examination happen at ingress. Therefore, egress ACL happens at the last moment and has precedence.

Redundant Rules

For BlackDiamond X8 series switches, BlackDiamond 8800 series switches, E4G-200 and E4G-400 cell site routers, and Summit family switches, eliminate redundant rules (any with the EXACT same match criteria) in the policy file. If two rules have identical match conditions, but different actions, the second rule is rejected by the hardware.

For example, the two following ACL entries are not allowed:

```
entry DenyNMR {
  if {
    protocol 17;
    destination-port 161;
  } then {
    deny;
    count denyNMR;
  }
}
entry DenyNIC {
  if {
    protocol 17;
    destination-port 161;
  } then {
    deny;
    count denyNIC;
  }
}
```

Applying ACL Policy Files

A policy file intended to be used as an ACL is applied to a port, VLAN, or to all interfaces (the `any` keyword). Use the name of the policy file for the `<aclname>` parameter in the CLI command. To apply an ACL policy, use the following command:

```
configure access-list <aclname> [any | ports <portlist> | vlan <vlanname>] {ingress | egress}
```

If you use the `any` keyword, the ACL is applied to all the interfaces and is referred to as the wildcard ACL. This ACL is evaluated for any ports without specific ACLs, and it is also applied to any packets that do not match the specific ACLs applied to the interfaces.

If an ACL is already configured on an interface, the command will be rejected and an error message displayed.

To remove an ACL from an interface, use the following command:

```
unconfigure access-list <policy-name> {any | ports <portlist> | vlan <vlanname>}
{ingress | egress}
```

To display which interfaces have ACLs configured, and which ACL is on which interface, use the following command:

```
show access-list {any | ports <portlist> | vlan <vlanname>} {ingress | egress}
```

This section describes the following topics:

- [Displaying and Clearing ACL Counters on page 685](#)
- [Example ACL Rule Entries on page 685](#)

Displaying and Clearing ACL Counters

To display the ACL counters, use the following command:

```
show access-list counter {<countername>} {any | ports <portlist> | vlan <vlanname>}
{ingress | egress}
```

To clear the access list counters, use the following command:

```
clear access-list {dynamic} counter {<countername>} {any | ports <portlist> | vlan
<vlanname>} {ingress | egress}
```

Example ACL Rule Entries

The following entry accepts all the UDP packets from the 10.203.134.0/24 subnet that are destined for the host 140.158.18.16, with source port 190 and a destination port in the range of 1200 to 1250:

```
entry udpacl {
  if {
    source-address 10.203.134.0/24;
    destination-address 140.158.18.16/32;
    protocol udp;
    source-port 190;
    destination-port 1200 - 1250;
  } then {
    permit;
  }
}
```

The following rule entry accepts TCP packets from the 10.203.134.0/24 subnet with a source port larger than 190 and ACK & SYN bits set and also increments the counter *tcpcnt*. The packets will be forwarded using QoS profile QP3. This example works only with BlackDiamond 8000 c-, e, xl-, and xm-series modules, and Summit family switches, since the match condition source-port > 190 alone will create more than 118 rules in the hardware:

```
entry tcpacl {
  if {
    source-address 10.203.134.0/24;
    protocol TCP;
    source-port > 190;
    tcp-flags syn_ack;
  } then {
    permit;
    count tcpcnt ;
  }
}
```

```
    qosprofile qp3;
  }
}
```

The following example denies ICMP echo request (ping) packets originating from the 10.203.134.0/24 subnet, and increments the counter *icmpcnt*:

```
entry icmp {
  if {
    source-address 10.203.134.0/24;
    protocol icmp;
    icmp-type echo-request;
  } then {
    deny;
    count icmpcnt;
  }
}
```

The following example prevents TCP connections from being established from the 10.10.20.0/24 subnet, but allows established connections to continue, and allows TCP connections to be established to that subnet. A TCP connection is established by sending a TCP packet with the SYN flag set, so this example blocks TCP SYN packets. This example emulates the behavior of the ExtremeWare permit-established ACL command:

```
entry permit-established {
  if {
    source-address 10.10.20.0/24;
    protocol TCP;
    tcp-flags syn;
  } then {
    deny;
  }
}
```

The following entry denies every packet and increments the counter *default*:

```
entry default {
  if {
  } then {
    deny;
    count default;
  }
}
```

The following entry permits only those packets with destination MAC addresses whose first 32 bits match 00:01:02:03:

```
entry rule1 {
  if {
    ethernet-destination-address 00:01:02:03:01:01 ff:ff:ff:ff:00:00 ;
  } then {
    permit ;
  }
}
```

The following entry denies IPv6 packets from source addresses in the 2001:db8:c0a8::/48 subnets and to destination addresses in the 2001:db8:c0a0:1234::/64 subnets:

```
entry ipv6entry {
  if {
    source-address 2001:DB8:C0A8:: / 48;
    destination-address 2001:DB8:C0A0:1234:: / 64;
  } then {
    deny;
  }
}
```

Access lists have entries to match an Ethernet type. So the user needs to be careful when configuring access lists to deny all traffic. For example, the following rule entries permit traffic only to destination 10.200.250.2 and block any other packet.

```
entry test_policy_4 {
  if {
    source-address 0.0.0.0/0;
    destination-address 10.200.250.2/32;
  } then {
    permit;
    count test_policy_permit;
  }
}
```

```
# deny everyone else
entry test_policy_99 {
  if {
  } then {
    deny;
    count test_policy_deny;
  }
}
```

Since the deny section does not specify an Ethernet type, all traffic other than IP packets destined to 10.200.250.2/32 are blocked, including the ARP packets. To allow ARP packets, add an entry for the Ethernet type, 1x0806, as shown below.

```
entry test_policy_5 {
  if {
    ethernet-type 0x0806;
  } then {
    permit;
    count test_policy_permit;
  }
}
```

The following entries use vlan-ids to set up meters based on individual VLANs.

```
myServices.pol
  entry voiceService {
    if {
      vlan-id 100;
    } then {
      meter voiceServiceMeter;
    }
  }
}
```

```
entry videoService {
  if {
    vlan-id 101;
  } then {
    meter videoServiceMeter;
  }
}
```

...and so on.

To bind this ACL to a port with `vlan-id` match criteria use the following command:

```
config access-list myServices port <N>
```

The following entry shows how to take action based on VLAN tag priority information. In this example, the `dot1p` match keyword is used to allow and count every tagged packet with a VLAN priority tag of 3.

```
entry count_specific_packets {
  if {
    dot1p 3;
  } then {
    count allowed_pkts;
    permit;
  }
}
```

ACL Mechanisms

For many applications of ACLs, it is not necessary to know the details of how ACLs work. However, if you find that your application of ACLs is constrained by hardware limitations, you can often rearrange the ACLs to use the hardware more efficiently. The following sections go into some detail about how the ACLs use hardware resources, and provide some suggestions about how to reorder or rewrite ACLs to use fewer resources.

- [ACL Slices and Rules on page 688](#)
- [ACL Counters—Shared and Dedicated on page 704](#)

ACL Slices and Rules

The Summit family switches (whether or not included in a SummitStack), BlackDiamond X8 series switches and BlackDiamond 8000 c-, e, xl-, and xm-series modules use a mechanism different from the earlier Summit series and BlackDiamond 8800 series switches to implement ACLs. The same architecture and guidelines apply to both platforms.



NOTE

This feature applies only to BlackDiamond X8 series switches, BlackDiamond 8000 series modules and Summit family switches.

Instead of the per port masks used in earlier switches, these platforms use slices that can apply to any of the supported ports. An ACL applied to a port may be supported by any of the slices.

For Summit family switches and BlackDiamond 8800 a- and e- series modules, the slice support is as follows:

- Summit X450a series switches and BlackDiamond 8800 a-series modules—Each group of 24 ports has 16 slices with each slice having enough memory for 128 ingress rules and actions.
- Summit X150, X250e, X350, and X450e series switches and BlackDiamond 8800 e-series modules—Each group of 24 ports has 8 slices with each slice having enough memory for 128 ingress rules and actions.
- Summit X440 series switches—each group of 24 ports has 4 slices with each slice having enough memory for 256 ingress rules.
- Summit X460 series switches—
 - Each group of 24 ports has 4 slices with each slice having enough memory for 128 egress rules.
 - Each group of 24 ports has 16 slices with each slice having enough memory for 256 ingress rules.
- Summit X480 series switches—
 - Each group of 48 ports has 4 slices with each slice having enough memory for 256 egress rules.
 - Each group of 48 ports has 16 internal slices with each slice having enough memory for 512 ingress rules plus the external slice.
- Summit X650 series switches—
 - Each group of 12 ports has 4 slices with each slice having enough memory for 128 egress rules.
 - Each group of 12 ports has 12 slices; the first 8 slices hold 128 ingress rules each, and the last 4 slices hold 256 ingress rules each, which adds up to 2048 ingress rules.
- Summit X670 switches and BlackDiamond X8 series switches—
 - Each group of 48 ports has 4 slices with each slice having enough memory for 256 egress rules.
 - Each group of 48 ports has 10 slices; the first 4 (0-3) slices hold 128 ingress rules each, and the last 6 (4-9) slices hold 256 ingress rules each, which adds up to 2048 ingress rules.

**NOTE**

Egress ACLs are supported on BlackDiamond X8 series switches, BlackDiamond 8000 c-, xl-, and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit X460, X480, X650, and X670 series switches only.

Figure 89 shows the 16 slices and associated rule memory for Summit X450a series switches or BlackDiamond 8800 a-series module.

Figure 89: Slice Support for Summit X450a Series Switches and BlackDiamond 8800 a-Series Modules

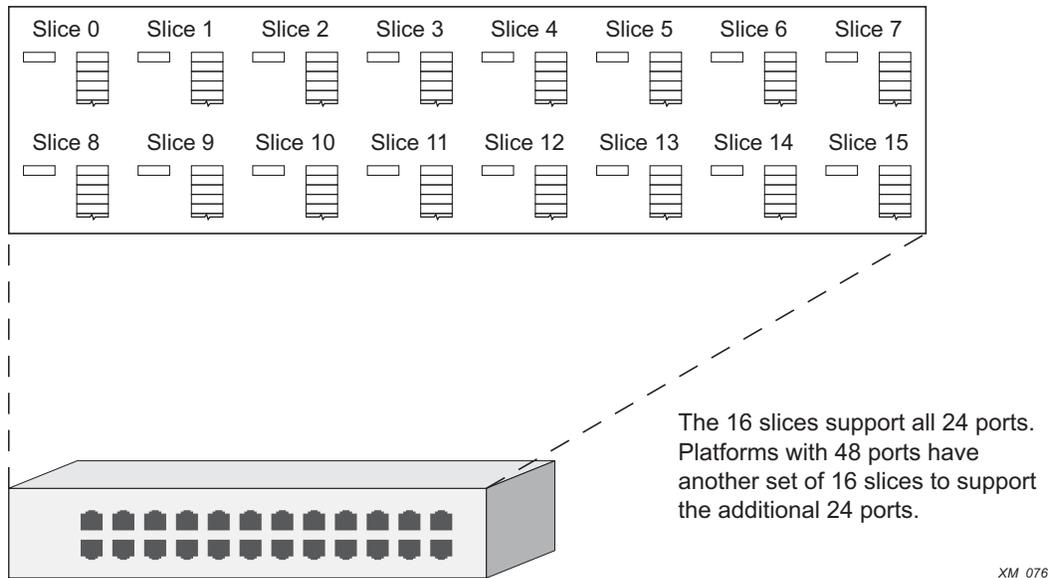
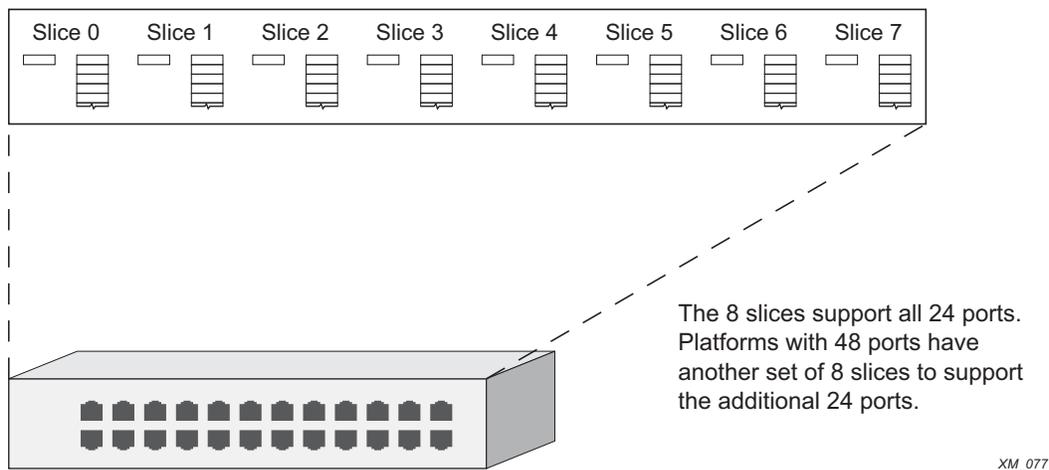


Figure 90 shows the 8 slices and associated rule memory for a Summit X150, X250e, X350, or X450e series switch or a BlackDiamond 8000 e-series module.

Figure 90: Slice Support for Summit X150, X250e, X350, and X450e Series Switches and BlackDiamond 8000 e-Series Modules



For BlackDiamond 8000 c-, xl-, and xm-series modules, the slice support for the cards is as follows:

- 10G1Xc—
 - Its single port has 4 slices with each slice having enough memory for 128 egress rules.
 - Its single port has 16 slices with each slice having enough memory for 256 ingress rules.
- G8Xc—
 - Its 8 ports have 4 slices with each slice having enough memory for 128 egress rules.
 - Its 8 ports have 16 slices with each slice having enough memory for 256 ingress rules.
- 10G4Xc/10G8Xc—
 - Each group of 2 ports has 4 slices with each slice having enough memory for 128 egress rules.
 - Each group of 2 ports has 16 slices with each slice having enough memory for 256 ingress rules.
- 10G24X-c—
 - Each group of 12 ports has 4 slices with each slice having enough memory for 128 egress rules.
 - Each group of 12 ports has 12 slices with each of the first 8 slices having enough memory for 128 ingress rules and each of the last 4 slices having enough memory for 256 ingress rules.
- G96T-c—
 - Each group of 48 ports has 4 slices with each slice having enough memory for 256 egress rules.
 - Each group of 48 ports has 16 slices with each slice having enough memory for 512 ingress rules.
- G48Tc/G48Xc/G24Xc—
 - Each group of 24 ports has 4 slices with each slice having enough memory for 128 egress rules.
 - Each group of 24 ports has 16 slices with each slice having enough memory for 256 ingress rules.
- G48X-xl/G48T-xl—
 - Its 48 ports have 4 slices with each slice having enough memory for 256 egress rules.
 - Its 48 ports have 16 internal slices with each slice having enough memory for 512 ingress rules.
- 10G8X-xl—
 - Each group of 4 ports has 4 slices with each slice having enough memory for 256 egress rules.
 - Each group of 4 ports has 16 internal slices with each slice having enough memory for 512 ingress rules.
- 40G6X-xm and BlackDiamond X8 series switches—
 - -Each group of 24 ports has 4 slices with each slice having enough memory for 256 egress rules.
 - -Each group of 24 ports has 10 slices with each slice having enough memory for 256 ingress rules.

This architecture also allows a single slice to implement ACLs that are applied to more than one port. When an ACL entry is applied, if its match conditions do not conflict with an already existing ACL, the entry is added to the rule memory of an already populated slice. Because the slices are much more flexible than masks, a much wider variety of rule entries can use the same slice.

When ACLs are applied, the system programs each slice to select parts of the packet information to be loaded into it. For example, one possible way a slice can be programmed allows it to hold the information about a packet's ingress port, source and destination IP address, IP protocol, source and destination Layer 4 ports, DSCP value, TCP flag, and if it is a first fragment. Any rule entry that consists of match conditions drawn from that list is compatible with that slice. This list of conditions is just one example. A complete description of possible ways to program a slice is discussed in [“Compatible and Conflicting Rules” on page 694](#).

In the following example, the two rule entries are compatible and require only one slice in hardware even though they are applied to different ports. The following entry is applied to port 1:

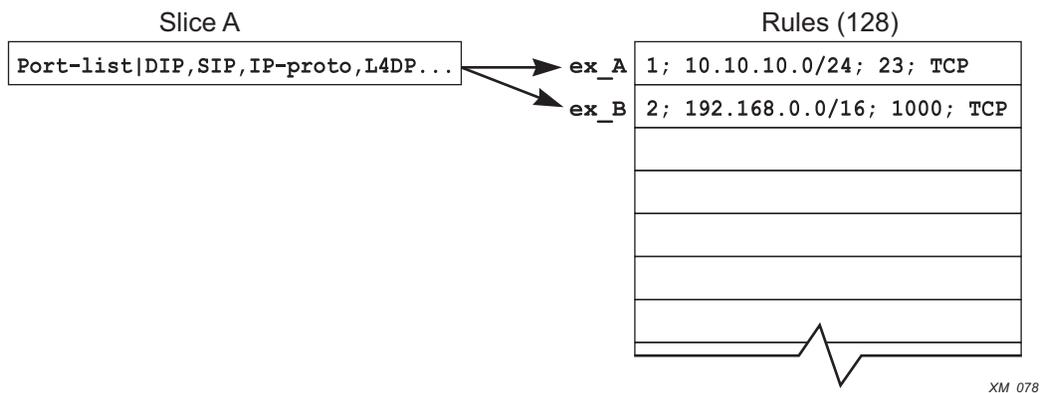
```
entry ex_A {
  if {
    source-address 10.10.10.0/24 ;
    destination-port 23 ;
    protocol tcp ;
  } then {
    deny ;
  }
}
```

and the following entry is applied to port 2:

```
entry ex_B {
  if {
    destination-address 192.168.0.0/16 ;
    source-port 1000 ;
    protocol tcp ;
  } then {
    deny ;
  }
}
```

Both of these ACLs could be supported on the same slice, since the match conditions are taken from the example list discussed earlier. This example is shown in [Figure 91](#). In the example, we refer to slice A, even though the slices are numbered. Slice A just means that one slice is used, but does not specify a particular slice. Some rules require more than one slice, so we use letters to show that different slices are used, but not which specific slices.

Figure 91: ACL Entry ex_A and ex_B



There are cases where compatible ACLs require using a different slice. If the memory associated with a slice is filled with rule entries, then another slice will be used to process any other compatible entries.

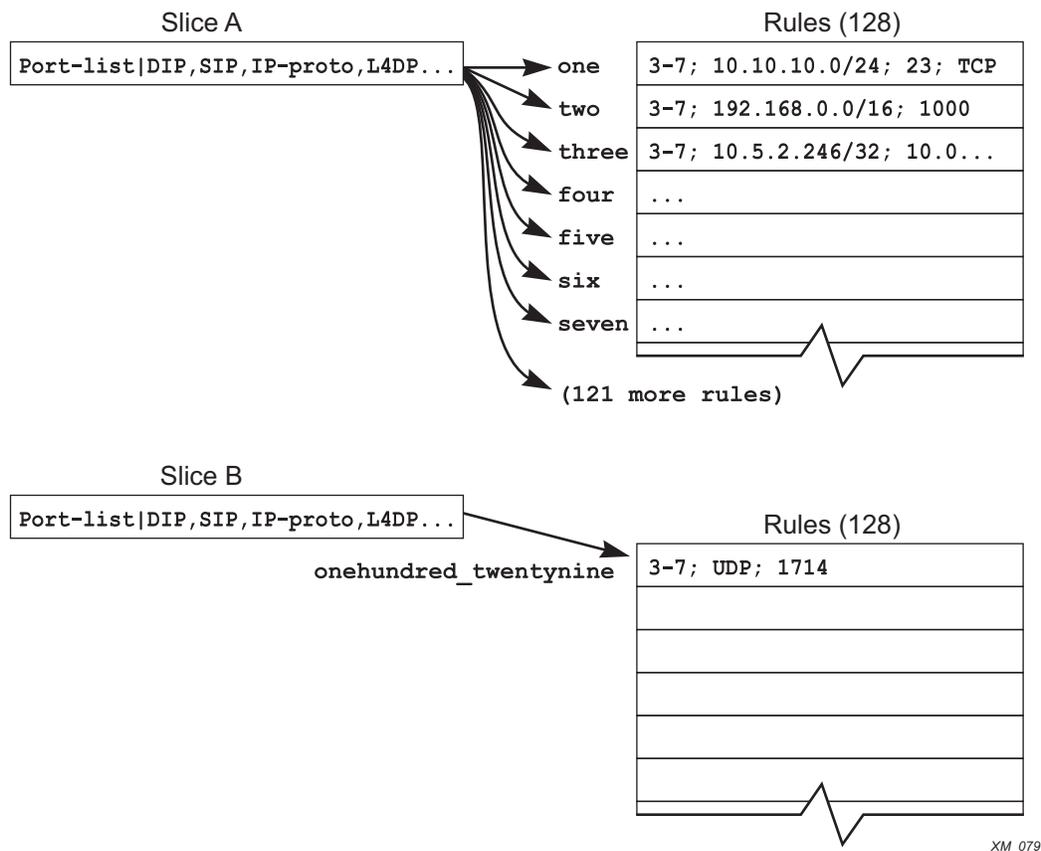
For example, consider the following 129 rule entries applied to ports 3-7:

```
entry one {
  if {
    source-address 10.66.10.0/24 ;
    destination-port 23 ;
    protocol tcp ;
  }
}
```

```
    } then {
        deny ;
    }
}
entry two {
    if {
        destination-address 192.168.0.0/16 ;
        source-port 1000 ;
        protocol tcp ;
    } then {
        deny ;
    }
}
entry three {
    if {
        source-address 10.5.2.246/32 ;
        destination-address 10.0.1.16/32 ;
        protocol udp ;
        source-port 100 ;
        destination-port 200 ;
    } then {
        deny ;
    }
}

....
[The 125 intervening entries are not displayed in this example]
....
entry onehundred_twentynine {
    if {
        protocol udp ;
        destination-port 1714 ;
    } then {
        deny ;
    }
}
```

Figure 92 shows the result of applying the 129 entries. 128 of the entries are applied to one slice, and the final entry is applied to a different slice. If another compatible entry is applied from another port, for example, it will use Slice B.

Figure 92: ACL Entry One Through onehundred_twentynine

As entries are configured on the switch, the slices are programmed to implement the rules, and the rule memory is filled with the matching values for the rules. If a compatible slice is available, each entry is added to that slice.

Compatible and Conflicting Rules

The slices can support a variety of different ACL match conditions, but there are some limitations on how you combine the match conditions in a single slice. A slice is divided up into fields, and each field uses a single selector. A selector is a combination of match conditions or packet conditions that are used together. To show all the possible combinations, the conditions in [Table 73](#) are abbreviated.

Table 73: Abbreviations Used in Field Selector Table

Abbreviation	Condition
Ingress	
DIP	destination address <prefix> (IPv4 addresses only)
DIPv6/128	destination address <prefix> (IPv6 address with a prefix length longer than 64)
DIPv6/64	destination address <prefix> (IPv6 address with a prefix length up to 64)
DSCP	dscp <number>
Etype	ethernet-type <number>
First Fragment	first ip fragment

Table 73: Abbreviations Used in Field Selector Table (Continued)

Abbreviation	Condition
FL	IPv6 Flow Label
Fragments	fragments
IP-Proto	protocol <number>
L4DP	destination-port <number> (a single port)
L4-Range	A Layer 4 port range. For example, if you specify “protocol UDP” and “port 200 - 1200” in an entry, you have used a Layer 4 range. There are a total of sixteen Layer 4 port ranges. Also, you can have a source port range, or a destination port range, but not both kinds of ranges together in the same entry.
L4SP	source-port <number> (a single port)
MACDA	ethernet-destination-address <mac-address> <mask>
MACSA	ethernet-source-address <mac-address>
NH	IPv6 Next Header field. Use protocol <number> to match. See IP-Proto
OVID	This is not a match condition used in ACLs, but is used when an ACL is applied to VLANs. An ACL applied to a port uses a different field selector than an ACL applied to a VLAN. VLAN IDs are outer VLAN IDs unless specified as inner VLAN IDs.
packet-type	This selector is used internally and not accessible by users through explicit ACLs.
Port-list	This is not a match condition used in ACLs, but is used when an ACL is applied to ports, or to all ports (the wildcard ACL). An ACL applied to a port uses a different field selector than an ACL applied to a VLAN.
SIP	source address <prefix> (IPv4 addresses only)
SIPv6/128	source address <prefix> (IPv6 address with a prefix length longer than 64)
SIPv6/64	source address <prefix> (IPv6 address with a prefix length up to 64)
TC	IPv6 Traffic Class field. Use dscp <number>
TCP-Flags	TCP-flags <bitfield>
TPID	802.1Q Tag Protocol Identifier
TTL	Time-to-live
UDF	User-defined field. This selector is used internally and not accessible by users through explicit ACLs.
VID-inner	Inner VLAN ID
VRF	Virtual router and forwarding instance
Egress	
DestIPv6	destination-address <ipv6>
DIP	destination-address
Etype	ethernet-type
IP-Proto	protocol
L4DP	destination-port. Support only single L4 ports and not port ranges.
L4SP	source-port. Support only single L4 ports and not port ranges.
MACDA	ethernet-destination-address
MACSA	ethernet-source-address
NH	IPv6 Next Header field.
SIP	source-address
SIPv6	source-address <ipv6>

Table 73: Abbreviations Used in Field Selector Table (Continued)

Abbreviation	Condition
TC	IPv6 Traffic Class field.
Tcp-Flags	tcp-flags
TOS	ip-tos or diffserv-codepoint
VlanId	vlan-id
The following ingress conditions are not supported on egress: Fragments, first-fragment, IGMP-msg-type, ICMP-type, ICMP-code,	

The tables that follow list all the combinations of match conditions that are available. The possible choices for different collections of switches and modules are listed in the tables as follows:

- [Table 74](#)—BlackDiamond 8800 a-series, G48Te2, and 8500-G48T Modules and Summit X150, X250e, and X450a Series Switches.
- [Table 75](#)—BlackDiamond 8000 e-Series Modules and Summit X350 and X450e Series Switches (Continued)
- [Table 76](#)—BlackDiamond 8800 c-Series Modules
- [Table 77](#)—BlackDiamond 8900 10G24X-c Module and Summit X650 Series Switches
- [Table 78](#)—BlackDiamond 8900 xl-Series and G96Tc Modules and Summit X480 Series Switches.
- [Table 79](#)—BlackDiamond 8900 40G6X-xm Module, BlackDiamond X8 series switches and Summit X460 and X670 Switches.

Any number of match conditions in a single row for a particular field may be matched. For example if Field 1 has row 1 (Port-list) selected, Field 2 has row 8 (MACDA, MACSA, Etype, OVID) selected, and Field 3 has row 7 (Dst-Port) selected, any combination of Port-list, MACDA, MACSA, Etype, OVID, and Dst-Port may be used as match conditions.

If an ACL requires the use of field selectors from two different rows, it must be implemented on two different slices

Table 74: Field Selectors, G48Te2, and 8500 Series Modules and Summit X150, X250e, and X450a Series Switches

Field 1	Field 2	Field 3
Port-list	DIP, SIP, IP-Proto, L4DP, L4SP, DSCP, TCP-Flag, IP-FI	IpInfo(First-Fragment, Fragments)
L4DP, L4SP	DIP, SIP, IP-Proto, L4DP, L4-range, DSCP, TCP-Flag, IP-flag	Port
OVID, VID-inner	DIP, SIP, IP-Proto, L4-range, L4SP, DSCP, TCP-Flag, IP-flag	DSCP, TCP-Flag
Etype, OVID	DIPv6/128	OVID
IpInfo(First-Fragment, Fragments), OVID	SIPv6/128	IP-Proto, DSCP
Port, Dst-Port	DIPv6/64, SIPv6/64	L4-Range
Etype, IP-Proto	DIPv6/64, IP-Proto, DSCP, FL, TCP-Flag MACDA, MACSA, Etype, OVID MACDA, DIP, Etype, OVID MACSA, SIP, Etype, OVID	Dst-Port

Table 74: Field Selectors, G48Te2, and 8500 Series Modules and Summit X150, X250e, and X450a Series Switches (Continued)

Field 1	Field 2	Field 3
	"User Defined Field" 1	
	"User Defined Field" 2	

Table 75: Field Selectors, BlackDiamond 8800 G48Te and G48Pe Modules and Summit X350 and X450e Series Switches

Field 1	Field 2	Field 3
Port-list	DIP, SIP, IP-Proto, L4DP, L4SP, DSCP, TCP-Flag, IP-Flag	IpInfo(First-Fragment, Fragments)
L4DP, L4SP	DIP, SIP, IP-Proto, L4DP, L4-range, DSCP, TCP-Flag, IP-flag	Port
OVID, VID-inner	DIP, SIP, IP-Proto, L4-range, L4SP, DSCP, TCP-Flag, IP-flag	DSCP, TCP-Flag
Etype, OVID	DIPv6/128	OVID
Port, Dst-Port	SIPv6/128	Dst-Port
Etype, IP-Proto	DIPv6/64, IP-Proto, DSCP, FL, TCP-Flag MACDA, MACSA, Etype, OVID MACDA, DIP, Etype, OVID MACSA, SIP, Etype, OVID "User Defined Field" 1 "User Defined Field" 2	

Table 76: Field Selectors, BlackDiamond 8800 c-Series Modules

Field 1	Field 2	Field 3
Port-list	DIP, SIP, IP-Proto, L4DP, L4SP, DSCP, TCP-Flag, IP-Flag	IpInfo(First-Fragment, Fragments)
L4DP, L4SP	DIP, SIP, IP-Proto, L4DP, L4-range, DSCP, TCP-Flag, IP-flag	Port
OVID, VID-inner	DIP, SIP, IP-Proto, L4-range, L4SP, DSCP, TCP-Flag, IP-flag	DSCP, TCP-Flag
Etype, OVID	DIPv6/128	OVID
IpInfo(First-Fragment, Fragments), OVID	SIPv6/128	IP-Proto, DSCP
Port, Dst-Port	DIPv6/64, SIPv6/64	L4-Range
Etype, IP-Proto	DIPv6/64, IP-Proto, DSCP, FL, TCP-Flag	Dst-Port
VRF, OVID	MACDA, MACSA, Etype, OVID	
DSCP, VRF, IP-Proto	MACDA, DIP, Etype, OVID MACSA, SIP, Etype, OVID "User Defined Field" 1 "User Defined Field" 2 DIP, SIP, IP-Proto, L4DP, L4SP, DSCP, TCP-Flag, IpInfo(First-Fragment, Fragments)	

Table 76: Field Selectors, BlackDiamond 8800 c-Series Modules

Field 1	Field 2	Field 3
	DIP, SIP, IP-Proto, L4DP, L4-range, DSCP, TCP-Flag, IpInfo(First-Fragment, Fragments) DIP, SIP, IP-Proto, L4-range, L4SP, DSCP, TCP-Flag, IpInfo(First-Fragment, Fragments)	

Table 77: Field Selectors, BlackDiamond 8900 10G24X-c Module and Summit X650 Series Switches

Fixed Field	Field 1	Field 2	Field 3
Port-list	L4DP, L4SP OVID, VID-inner Etype, OVID IpInfo(First-Fragment, Fragments), OVID Port, Dst-Port Etype, IP-Proto VRF, OVID DSCP, VRF, IP-Proto	DIP, SIP, IP-Proto, L4DP, L4SP, DSCP, TCP-Flag, IP-Flag DIPv6/128 SIPv6/128 DIPv6/64, SIPv6/64 DIPv6/64, IP-Proto, DSCP, FL, TCP-Flag MACDA, MACSA, Etype, OVID MACDA, DIP, Etype, OVID MACSA, SIP, Etype, OVID "User Defined Field" 1 "User Defined Field" 2 DIP, SIP, IP-Proto, L4DP, L4SP, DSCP, TCP-Flag, IpInfo(First-Fragment, Fragments)	IpInfo(First-Fragment, Fragments) Port DSCP, TCP-Flag OVID IP-Proto, DSCP L4-Range Dst-Port

Table 78: Field Selectors, BlackDiamond 8900 xl-series and G96Tc Modules and Summit X480 Series Switches.

Fixed Field	Field 1	Field 2	Field 3
Port-list	DstPort TPID, OVID, VID-inner Etype, OVID InnerTPID, VID-inner OVID DSCP, IP-Proto	DIP, SIP, IP-Proto, L4DP, L4SP, DSCP, TCP-Flag, IP-Flag DIP, SIP, IP-Proto, L4SP, L4DP, DSCP, IpInfo(First-Fragment, Fragments), TCP-Flag SIPv6/128 DIPv6/128 DIPv6/64, IP-Proto, DSCP, FL, TCP-Flag MACDA, MACSA, Etype, OVID MACSA, SIP, Etype, OVID MACDA, DIP, Etype, OVID "User Defined Field" SIPV6/64, DIPV6/64 DIPV6/64	OVID(12bit) DstPort OVID OVID, VID-inner Etype, OVID VID-inner InnerTPID, OuterTPID

Table 79: Field Selectors, BlackDiamond 8900 40G6X-xm Module, BlackDiamond X8 Series Switches and Summit X460 and X670 Series Switches

Fixed Field	Field 1	Field 2	Field 3
Port-list	OVID, VID-inner Etype, OVID VID-inner IpInfo(First-Fragment, Fragments), OVID OVID IP-Proto, DSCP "User Defined Field" 1	DIP, SIP, IP-Proto, L4DP, L4SP, DSCP, IPFlag, TCP-Flag DIP, SIP, IP-Proto, L4DP, L4SP, DSCP, IpInfo(First-Fragment, Fragments) TCP-Flag DIPv6/128 SIPv6/128 DIPv6/64, IP-Proto, DSCP, FL, TCP-Flag MACDA, MACSA, OVID, Etype MACSA, OVID, Etype, SIP MACDA, OVID, Etype, DIP, IP-Proto "User Defined Field" 1 "User Defined Field" 2 DIPv6/64, SIPv6/64	OVID OVID, IpInfo(First-Fragment, Fragments) OVID, VID-inner OVID, Etype VID-Inner L4-Range FL UDF1[95..64]

Table 80: Field Selectors, Summit X440

Fixed Field	Field 1	Field 2	Field 3
Ingress Port List	Vlan, EtherType DstPort, DstMod, DstTrunk, SrcPort, SrcMod, SrcTrunk IpProtocol, TOS, VlanId 4-byte UDF	TTL, TcpControl, IpFlags, TOS, I4DstPort, L4SrcPort, IpProtocol, DstIp, SrcIp TTL, TcpControl, IpFrag, TOS, I4DstPort, L4SrcPort, IpProtocol, DstIp, SrcIp SrcIp6 DstIp6 TTL, TcpControl, IP6FlowLabel, TOS, IpProtocol, Ip6High Vlan, EtherType, SrcMac, DstMac Vlan, EtherType, SrcMac, SrcIp Vlan, EtherType, TTL, IpProtocol, DstIp, DstMac 16-byte UDF SrcIp6High, DstIp6High	Vlan, EtherType RangeCheck(I4 ports or vlans)

Egress ACLs. Each of the 4 egress slices can be configured to one of the 3 combinations below. The rules that can be installed into a particular slice should be a subset of the combination to which that slice is configured.

Following is the table of the available combinations:

- **Combination 1:**

```
<vlan-id, ethernet-source-address, ethernet-destination-address, ethernet-type>
```

- **Combination 2:**

```
<vlan-id, diffserv-codepoint/ip-tos, destination-address, source-address, protocol,
destination-port, source-port, tcp-flags>
```

- **Combination 3:**

```
<vlan-id, ip-tos, destination-address<ipv6>, source-address<ipv6>, protocol>
```

Use [Table 74](#) through [Table 79](#) to determine which ACL entries are compatible. If the entries are compatible, they can be on the same slice.

For example, the earlier example entries are applied to ports:

```
entry ex_A {
  if {
    source-address 10.10.10.0/24 ;
    destination-port 23 ;
    protocol tcp ;
  } then {
    deny ;
  }
}

entry ex_B {
  if {
    destination-address 192.168.0.0/16 ;
    source-port 1000 ;
  } then {
    deny ;
  }
}
```

Entry `ex_A` consists of the following conditions (using the abbreviations from [Table 73](#)), SIP, L4DP, and IP-Proto. Entry `ex_B` is DIP, L4SP. Since they are applied to ports, the selector for Field 1 is Port-list (the first item). The selector for Field 2 would be the first item, and Field 3 could be any item.

Our other example entries are also compatible with the entries `ex_A` and `ex_B`:

```
entry one {
  if {
    source-address 10.66.10.0/24 ;
    destination-port 23 ;
    protocol tcp ;
  } then {
    deny ;
  }
}
```

```
entry two {
  if {
    destination-address 192.168.0.0/16 ;
    source-port 1000 ;
  } then {
    deny ;
  }
}

entry three {
  if {
    source-address 10.5.2.246/32 ;
    destination-address 10.0.1.16/32 ;
    protocol upd ;
    source-port 100 ;
    destination-port 200 ;
  } then {
    deny ;
  }
}
```

Entry one is SIP, L4DP, and IP-Proto; entry two is DIP, and L4SP; entry three is SIP, DIP, IP-Proto, L4SP, and L4DP. All of these examples can use the first item in Field 2 in the tables.

However, if we add the following entry:

```
entry alpha {
  if {
    ethernet-destination-address 00:e0:2b:11:22:33 ;
  } then {
    deny ;
  }
}
```

this will not be compatible with the earlier one. Entry alpha is MACDA, and there is no MACDA in the first item for Field 2. Any entry with MACDA will have to use selector 7 or 8 from [Table 74](#) (or 6 or 7 from [Table 75](#), depending on the platform). If an entry requires choosing a different selector from the table, it is not compatible and must go into a different slice.

Rule Evaluation and Actions

When a packet ingresses the switch, its header is loaded into all the slices, and the header value is compared with the rule values. If the values match, the rule action is taken. Conflicting actions are resolved by the precedence of the entries. However, if rule entries are on different slices, then ACL counters can be incremented on each slice that contains a counter-incrementing rule.

Slice and Rule Use by Feature

A number of slices and rules are used by features present on the switch. You consume these resources when the feature is enabled.

- dot1p examination - enabled by default - 1 slice, 8 rules per chip
 - Slice A (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=packet-type)
- IGMP snooping - enabled by default - 2 slice, 2 rules
 - Slice A (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=packet-type)
 - Slice B (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=IP-Proto, TOS)
- VLAN without IP configured - 2 rules - 2 slices
 - Slice A (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=packet-type)
 - Slice C (F1=Port-list, F2=SIP, DIP, IP-PROTO, L4SP, L4DP, DSCP, F3=packet-type)
- IP interface - disabled by default - 2 slices, 3 rules (plus IGMP snooping rules above)
 - Slice A (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=packet-type)
 - Slice C (F1=Port-list, F2=SIP, DIP, IP-PROTO, L4SP, L4DP, DSCP, F3=packet-type)
- VLAN QoS - disabled by default - 1 slice, n rules (n VLANs)
 - Slice A or B (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=anything)
- port QoS - disabled by default - 1 slice, 1 rule
 - Slice D (F1=anything, F2=anything, F3=anything)
- VRRP - 2 slices, 2 rules
 - Slice A (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=packet-type)
 - Slice A or B (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=anything)
- EAPS - 1 slice, 1 rule (master), n rules (transit - n domains)
 - Slice A or B (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=anything)
- ESRP - 2 slices, 2 rules
 - Slice A (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=packet-type)
 - Slice A or B (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=anything)
- IPv6 - 2 slices, 3 rules
 - Slice A or B (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=anything)
 - Slice (F1=Port-list, F2=DIPV6, IPv6 Next Header Field, TC, F3=anything)
- Netlogin - 1 slice, 1 rule
 - Slice A or B (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=anything)
- VLAN Mirroring - 1 slice, n rules (n VLANs)
 - Slice E (F1=Port-list, F2=MACDA, MACSA, Etype, VID, F3=anything)
- Unicast Multiport FDB
 - 1 slice, 1+n rules in 24 port Summit series switches
 - 1 slice, 2+ n rules in 48 port Summit series and G48Ta, G48Pe cards
- VLAN Aggregation
 - 1 slice, 4 rules for the first subvlan configured and 1 slice, 2 rules for subsequent subvlan configuration

- Private VLAN
 - 2 slices, 3 rules when adding a non-isolated VLAN with loop-back port a to private VLAN
 - 1 slice, 3 rules when adding an isolated subscriber VLAN (without loopback port) to a private VLAN. 3 additional rules when a loopback port is configured in the above isolated subscriber VLAN
- ESRP Aware - 1 slice, 1 rule
 - Field 1: {Drop, OuterVlan, EtherType, PacketFormat, HiGig, Stage, StageIngress, Ip4, Ip6}
 - Field 2: {SrcIp, DstIp, L4SrcPort, L4DstPort, IpProtocol, DSCP, Ttl, Ip6HopLimit, TcpControl, IpFlags}
 - Field 3: {RangeCheck}
- ACL rule with mirror action is installed in a separate slice, and this slice cannot be shared by other rules without a mirror action.

**NOTE**

The user ACLs may not be compatible with the slice used by this ESRP rule. This may result in the reduction the number of rules available to the user by 127.

To display the number of slices used by the ACLs on the slices that support a particular port, use the following command:

```
show access-list usage acl-slice port <port>
```

To display the number of rules used by the ACLs on the slices that support a particular port, use the following command:

```
show access-list usage acl-rule port <port>
```

To display the number of Layer 4 ranges used by the ACLs on the slices that support a particular port, use the following command:

```
show access-list usage acl-range port <port>
```

System Configuration Example

The following example shows incremental configurations and their corresponding ACL resource consumption taken on a BlackDiamond 8800 switch with an a-series card.

- Default configuration including: dot1p examination and IGMP snooping:
 - 2 slices, 10 rules
- Add an IP interface to the configuration:
 - 2 slices, 13 rules
- Add port-based QoS to the configuration:
 - 2 slices, 14 rules
- Add VLAN-based QoS to the configuration:
 - 2 slices, 15 rules
- Add VRRP to the configuration:
 - 2 slices, 17 rules
- Add EAPS (Master mode) to the configuration:
 - 2 slices, 18 rules

- Add ESRP to the configuration:
 - 2 slices, 21 rules
- Add IPv6 routing (slowpath) to the configuration:
 - 4 slices, 24 rules
- Add Netlogin to the configuration:
 - 5 slices, 25 rules

**NOTE**

The slice and rule usage numbers given in this section are for the ExtremeXOS 12.4.1 release. They may vary slightly depending on the ExtremeXOS release.

ACL Error Messages

Errors may happen when installing an ACL policy on a port, VLAN, or all interfaces (wildcard). Following is a list of the most common error conditions and their resulting CLI error message:

- **Slice resource exceeded:** This happens when all slices are allocated for a given chip and an additional incompatible rule (see [“Egress ACLs” on page 699](#)) is installed which requires allocation of another slice.

```
Error: ACL install operation failed - slice hardware full for port 3:1
```

- **Rule resource exceeded:** This happens when all slices are allocated for a given chip and there is an attempt to install a compatible rule to the lowest precedence slice which already has 128 rules. This condition can be triggered with less than the full capacity number of rules installed. For example, if 15 of the slices each have less than 128 rules and there is an attempt to install 129 compatible rules, this error message will be displayed.

```
Error: ACL install operation failed - rule hardware full for port 3:1
```

- **Layer-4 port range exceeded:** This happens when more than 16 Layer 4 port ranges are installed on a single chip.

```
Error: ACL install operation failed - layer-4 port range hardware full for port 3:1
```

- **Incompatible fields selected:** This happens when the selected conditions can not be satisfied by the available single-slice field selections described in [“Compatible and Conflicting Rules” on page 694](#).

```
Error: ACL install operation failed - conditions specified in rule "r1" cannot be satisfied by hardware on port 3:1
```

- **UDF exceeded:** This happens in the rare case that the two available user-defined fields are exceeded on a given chip. UDF fields are used to qualify conditions which are not natively supported by the hardware. Currently, these include: ICMP Type and ICMP Code.

```
Error: ACL install operation failed - user-defined-field (UDF) hardware full for port 3:1
```

ACL Counters—Shared and Dedicated

You can configure rule compression in ACLs to be either *shared* or *dedicated*.

**NOTE**

This feature applies only to BlackDiamond 8800 switches and Summit family switches.

In the dedicated mode, ACL rules that have counters are assigned a separate rule space and the counter accurately shows the count of matching events. If the ACL with counter is applied to ports 1 and 2, and 10 packets ingress via port 1 and 20 packets ingress via port 2, the ACL counter value for ports 1 and 2 is 10 and 20 packets respectively. More space is used and the process is slower than shared. Dedicated is the default setting

In the shared mode, ACL space is reused even with counters. ACL counters count packets ingressing via all ports in the whole unit. If the ACL with the counter is applied to ports 1 and 2, and 10 packets ingress via port 1, and 20 packets ingress via port 2, the ACL counter value is 30 each of ports 1 and 2 instead of 10 and 20. The process is faster—as fast as applying an ACL without the counters—and saves space.

The shared/dedicated setting is global to the switch; that is, the option does not support setting some ACL rules with shared counters and some with dedicated counters.

Use the following command to configure the shared or dedicated mode:

```
configure access-list rule-compression port-counters [shared | dedicated]
```

Use the following command to view the configuration:

```
show access-list configuration
```

The shared or dedicated mode does not affect any ACLs that have already been configured. Only ACLs entered after the command is entered are affected.

To configure all ACLs in the shared mode, the command must be entered before any ACLs are configured or have been saved in the configuration when a switch is booted.

External TCAM ACLs

In addition to internal ACL tables, BlackDiamond 8900 xl-series modules and Summit X480 series switches can install ACL rules into a ternary content addressable memory (TCAM). External TCAMs can hold a much greater number of ACL rules than internal ACL memories. External TCAMs are used for user ACLs when the switch runs in either `acl-only` mode or `l2-and-l3-and-acl` mode. If the switch is not running in one of these two modes, internal ACL memory is used instead.



NOTE

This feature applies only to BlackDiamond 8900 xl-series modules and Summit X480 series switches.

To set the system to `acl-only` mode, issue the following command, save, and reboot:

```
configure forwarding external-tables acl-only
```

To set the system to `l2-and-l3-and-acl` mode, issue the following command, save, and reboot:

```
configure forwarding external-tables l2-and-l3-and-acl
```

In `acl-only` mode, the following condition sets and the following number of rules are supported:

```
Ipv4 Rules: (The maximum is 61440 such rules.)
{
  <ethernet-source-address>, <ethernet-destination-address>,
  <vlan or vlan-id>, <source-address ipv4 addr>,
  <destination-address ipv4 addr>, <protocol>,
  <source-port 14 port or port-range>,
```

```
<destination-port 14 port or port-range>,
(Note, only one 14 port range per rule is supported)
<tcp-flags>
}
Ipv6 Rules: (The maximum is 2048 such rules.)
{
  <ethernet-source-address>, <ethernet-destination-address>,
  <vlan or vlan-id>, <source-address ipv6 addr>,
  <destination-address ipv6 addr>, <diffserv-codepoint>, <protocol>,
  <source-port 14 port or port-range>,
  <destination-port 14 port or port-range>,
  (Note, only one 14 port range per rule is supported)
  <tcp-flags>
}
```

In 12-and-13-and-acl mode the following condition sets and the following number of rules are supported:

```
Ipv4 Rules: (The maximum is 57344 such rules.)
{
  <vlan or vlan-id>, <source-address ipv4 addr>,
  <destination-address ipv4 addr>, <protocol>,
  <source-port 14 port or port-range>,
  <destination-port 14 port or port-range>,
  (Note, only one 14 port range per rule is supported)
  <tcp-flags>
}
```

**NOTE**

In either of the two available external TCAM ACL modes, configuring more than 55000 rules is not recommended, because when the number of rules is greater than 55000, the system runs low on memory and can experience unexpected crashes.

Policy-Based Routing

This section describes the following topics:

- [Layer 3 Policy-Based Redirect on page 707](#)
- [Layer 2 Policy-Based Redirect on page 708](#)
- [LAG Port Selection](#)
- [Policy-Based Redirection Redundancy on page 711](#)

**NOTE**

Policy-Based Routing is available only on the platforms listed for this feature in Appendix A, “Feature License Requirements.” Refer to [“Load Sharing Rules and Restrictions for All Switches” on page 294](#) for information on applying ACLs to LAG ports.

Layer 3 Policy-Based Redirect

Policy-Based Routing allows you to bypass standard Layer 3 forwarding decisions for certain flows.

Typically, in a Layer 3 environment, when an IP packet hits an Ethernet switch or router, the Layer 3 processing determines the nexthop and outgoing interface for the packet, based only on the packet's destination address. The Layer 3 processing does so by looking up the IP Forwarding Table; this forwarding table itself is populated either by static routes or by routes learned dynamically from routing protocols such as OSPF and RIP.

With Policy-Based Routing, you can configure policies to use a different nexthop than what the routing lookup would have chosen. The switch first compares packets to the ACL rule entries. If there is a match, the packet is forwarded to the destination identified by the redirect action modifier. If there is no match, the packet is forwarded based on normal routing, in other words, by looking up a route in the IP Forwarding Table.

When there is a match with a redirect ACL rule, the matched traffic is redirected to the nexthop specified in the action.



NOTE

The IP packet itself is not modified, but only redirected to the port where the nexthop entry resides. The original IP destination address and source address are retained in the packet. The TTL is decremented and the IP checksum is recalculated.

The applications for Policy-Based Routing are quite diverse, since the functionality can be used to set policies on how flows identified by any Layer 2 to Layer 7 field (bounded by the switch's ACL syntax) are forwarded. Deployment scenarios include:

- Forwarding flows for certain applications, for example, all HTTP traffic to designated server(s).
- Redirecting flows from certain source IP addresses for security and other applications.

Policy-Based Routing is implemented using ACLs, so it inherits the capabilities and limitations of ACLs. All the matching conditions used for ACLs can be used for Policy-Based Routing. The destination IP address can be an IPv4 or IPv6 unicast address.

When a switch finds a matching ACL rule, it forwards the packet to the redirect IP address as specified in the rule without modifying the packet (except as noted above).

The traffic flow is redirected only after applying the ACL to the port and only when the redirect IP address's adjacency is resolved. When the ARP or NDP table does not have the information to reach the redirect IP address, the packet is routed based on the Layer 3 routing table. When the switch does not know how to reach the redirect IP address in the rule, the rule is installed with a warning, and traffic is not redirected until the address is resolved in the ARP or NDP table. After the address is resolved, the traffic is redirected.

When L3 routed IP traffic matches applied ACL, the packet will be redirected to all ports specified in the redirect port-list as long as these ports are part of the true Egress VLAN.

When L3 routed IP multicast packet matches applied ACL, the packet will be redirected only to ports specified in the redirect port-list that are part of the Ingress VLAN.

To configure Policy-Based Routing, you configure an ACL on your switch. You can apply an ACL policy file, or use a dynamic ACL.

The following is an example ACL rule entry that redirects any TCP traffic with a destination port of 81 to the device at IP address 3.3.3.2:

```
entry redirect_port_81 {
  if {
    protocol tcp;
    destination-port 81;
  } then {
    redirect 3.3.3.2;
  }
}
```

Use the following procedure:

- 1 Issue the following command to prevent the redirect IP address from clearing from the ARP or NDP table due to a timeout:

```
enable iparp refresh
```

- 2 Configure the ACL, either by applying an ACL policy file similar to the example, or a dynamic ACL.
- 3 Ping or send traffic so that the redirect IP adjacency is resolved.

You may want to create a static ARP or NDP entry for the redirect IP address, so that there will always be a cache entry.



NOTE

An ACL can be rejected on modules and switches that support Policy-Based Routing when, because these have different amounts of hardware resources, one module or switch has exhausted its resources. IPv6 Policy-Based Routing is not supported for traffic with Hop-by-Hop extension headers. Traffic will continue to be hardware forwarded, and will not be processed in slow path.

Layer 2 Policy-Based Redirect

This feature allows matching packets to override the normal forwarding decision and be Layer 2 switched to the specified physical port. This is accomplished using an additional packet ACL lookup. While similar to the “Layer 3 Policy-Based Redirect” feature described above, it differs in that the packet is not modified for Layer 3 routing based on a new IP redirect nexthop. Instead, the packet uses the packet format based on the forwarding decision. When the packet is Layer 2-switched, the packet egresses the redirect port unmodified. When the packet is Layer 3-switched, the packet egresses with the Layer 3 packet modifications of the nexthop found by the normal Layer 3 forwarding lookups. This feature applies to IPv4 unicast, multicast, and broadcast traffic and IPv6 unicast traffic.

The following ACL actions are added in support of this feature:

```
redirect-port-list <port>; redirect-port-list <port-list>
```

You must specify the `<port>` argument in the correct format for the switch platform. On supporting switches and modules, this argument must be in the format `<slot>:<port>` and on Summit family switches, this argument must be in the format `<port>`.

The `<port-list>` argument is simply a comma separated list of `<port>` arguments. Whitespace between `<port>` arguments is not allowed.

Here is an example of valid `<port-list>` syntax :

```
redirect-port-list 2:1,2:5,5:3; and
redirect-port-list 3,24,5;
```

Here is an example of invalid <port-list> syntax :

```
redirect-port-list 2:1 2:5 5:3;
redirect-port-list 2, 4, 5;
```

The policy shown below redirects any TCP traffic with source Layer 4 port 81 to physical port 3:2.

```
entry one {
  if {
    protocol tcp;
    source-port 81;
    destination-port 200 ;
  } then {
    count num_pkts_redirected;
    redirect-port 3:2;
  }
}
```

The policy shown below redirects any in-profile traffic as defined by the meter configuration to physical port 14. The out-of-profile traffic is subject to the action specified in the meter “out-action” configuration.

```
entry one {
  if {
  } then {
    meter redirected_traffic;
    count num_pkts_redirected;
    redirect-port 14;
  }
}
```

The policy shown below redirects all traffic with source IP matching 192.168.1.1/24; to physical ports 2:10 and 4:7.

```
entry one {
  if {
    source-address 192.168.1.1/24;
  } then {
    count num_pkts_redirected;
    redirect-port-list 2:10,4:7;
  }
}
```

If an incorrect port format is used or if the port number specified is out of range, the following error message is displayed:

```
*BD-8810.68 # check policy l2pbr

Error: Policy l2pbr has syntax errors
Line 7 : 12:3 is not a valid port.
BD-8810.70 # check policy l2pbr
Error: Policy l2pbr has syntax errors
Line 7 : 77 is not a valid port.
```

When this feature is used on BlackDiamond 8000 series modules, the traffic egressing the redirect-port can be either tagged or untagged depending on the redirect-port VLAN configuration. [Table 81](#) provides the details.

Table 81: VLAN Format of Traffic Egressing Redirect-Port

ACL Hardware Type	Redirect-Port Not in Egress VLAN	Redirect-Port Tagged in Egress VLAN	Redirect-Port Untagged in Egress VLAN
<i>BlackDiamond 8000 c-, e-, xl-, and xm-series modules</i>	Dropped	VLAN Tagged	Untagged

Be aware of the following important implementation notes:

- Using the “redirect-port” action on Broadcast and L2 routable Multicast packets will redirect those traffic only to ports specified in the redirect port-list that are part of the Ingress VLAN.
- Using the “redirect-port” action with a disabled port causes traffic to be dropped.
- Using the “redirect-port” action overrides Layer 2 echo kill; the result is that a packet can be made to egress the ingress port at Layer 2.
- For systems with a- and e- series hardware that has the larger table size, packets with IP options do not match ACLs using the “redirect-port” action. Systems with hardware that has the smaller table size do not have this capability. On these systems, packets with IP options will match ACLs that use the “redirect-port” action, and be dropped.
- The `redirect-port-list` action modifier is targeted towards L2 scenarios. This action is not supported in slow path ACL's. The following list summarizes the behavior of the `redirect-port-list` action modifier under certain situations
 - a When a packet that would normally be L3 routed, matches the applied ACL, the packet is redirected to all ports specified in the redirect port-list as long as these ports are part of the true egress Vlan.
 - b When a broadcast/L2 routable multicast packet matches the applied ACL, this packet is redirected only to those ports specified in the redirect port-list that are part of the ingress Vlan.
 - c When an IP multicast packet that would normally be L3 routed matches the applied ACL, the packet is redirected only to ports specified in the redirect port-list that are part of the ingress Vlan.

LAG Port Selection

This feature allows you to apply an ACL that causes matching packets to egress a specific port in a link aggregation (or load-sharing) group.



NOTE

This feature applies only to BlackDiamond 8000 series modules and Summit family switches.

The following ACL action is added in support of this feature:

```
redirect-port-no-sharing <port>
```

The ACL overrides any load-sharing algorithm hash that is generated based on the lookup results.

Limitations include the following:

- If the selected port in a load-sharing group is down, the packets will be dropped.
- Like the `redirect-port` action, the specified port must be a member of the egress VLAN.

Following is an example of a configuration and ACL policy that directs traffic matching 10.66.4.10 to LAG port 3:

```
enable sharing 2 group 2,3

radiomgmt.pol:
entry one {
    if {
        destination-address 10.66.4.10/32;
    } then {
        redirect-port-no-sharing 3;
    }
}

config access-list radiomgmt any
```

This example would direct inband management traffic to specific radios connected to specific ports within a load-sharing group.

Policy-Based Redirection Redundancy

Policy-based redirection redundancy is described in the following sections:

- [Multiple Nexthop Support on page 711](#)
- [Health Checking for ARP, NDP, and Ping on page 712](#)
- [Packet Forward/Drop on page 712](#)
- [Example—Network Diagram on page 713](#)

Multiple Nexthop Support

As discussed above, Layer 3 and Layer 2 policy-based redirect support only one nexthop for one policy-based entry. Multiple nexthops with different priorities can be configured. A higher priority is denoted with a higher number; for example, “priority 5” has a higher precedence than “priority 1.” When a high priority nexthop becomes unreachable, another preconfigured nexthop, based on priority, replaces the first. This is done by first creating a *flow-redirect name* that is used to hold nexthop information. User-created flow-redirect names are not case-sensitive.

Use the following command:

```
create flow-redirect <flow-redirect-name>
```

To delete the flow-redirect name, use

```
delete flow-redirect <flow-redirect-name>
```

Then information for each nexthop, including a defined priority, is added one by one to the new flow-redirect name. Use the following command:

```
configure flow-redirect <flow-redirect-name> add nexthop <ipaddress> priority <number>
```



NOTE

You can add IPv4 or IPv6 nexthops to a flow-redirect policy, but both types are not supported in the same policy.

To delete a nexthop, use the following command:

```
configure flow-redirect <flow-redirect-name> delete nexthop {<ipaddress> | all }
```

Because an ACL does not recognize the virtual routing concept, one policy-based routing is used for multiple virtual routing entries when a VLAN-based virtual router is used for one port. Configuring a virtual router into a flow-redirect allows policy-based routing to work for only one specific virtual router. Use the following command:

```
configure flow-redirect <flow-redirect-name> vr <vr-name>
```



NOTE

Configuring the virtual router parameter is not supported on BlackDiamond 8800 series switches and Summit family switches.



NOTE

Flow-redirect does not work on user-created virtual routers.

Finally, a new action modifier, `redirect-name`, is used to specify the flow-redirect name in an ACL rule entry.

```
entry redirect_redundancy {
  if match all {
    source-address 1.1.1.100/24 ;
  } then {
    permit ;
    redirect-name <name>
  }
}
```

Health Checking for ARP, NDP, and Ping

Policy-based redirection redundancy requires the determination of the reachability or unreachability of the active next hop and the other configured next hops. This feature can use ARP, NDP or Ping checking to make the determination.

To configure health checking for a specific flow-redirect-name, use the following command:

```
configure flow-redirect <flow-redirect-name> health-check [ping | arp | neighbor-discovery]
```

To configure the ping interval and miss count for a nexthop, use the following command:

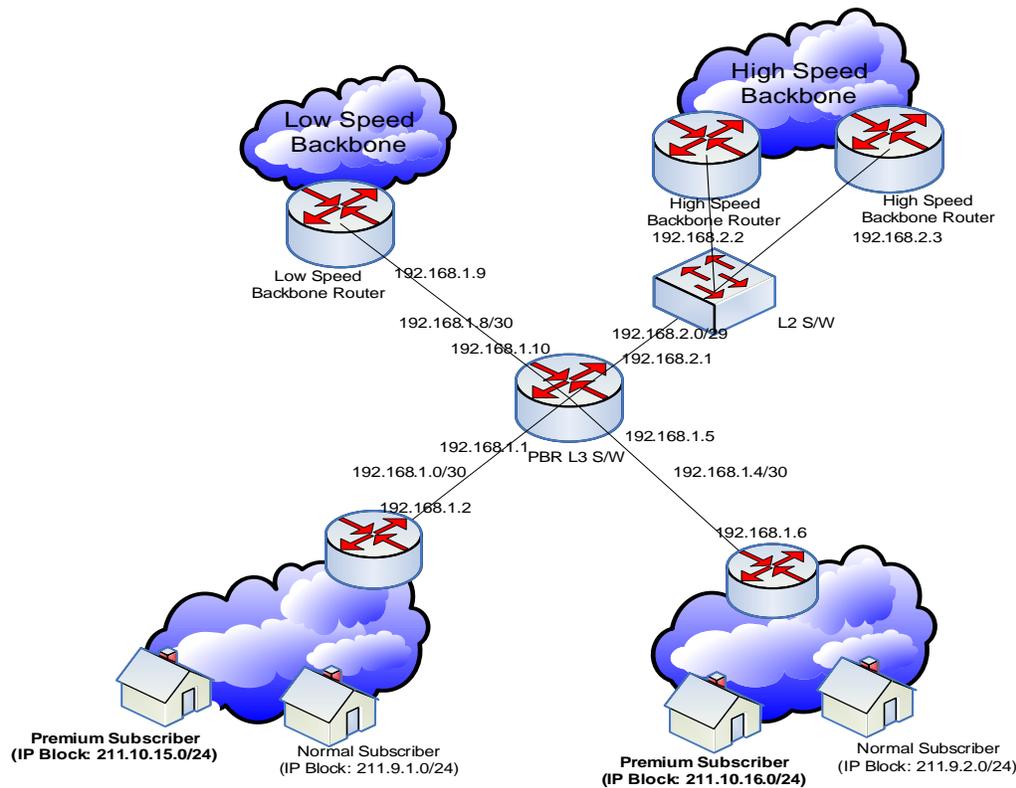
```
configure flow-redirect <flow-redirect-name> nexthop <ipaddress> ping health-check interval <seconds> miss <number>
```

Packet Forward/Drop

The default behavior for policy-based routing when all nexthops are unreachable is to route packets based on the routing table. Policy-based routing redundancy adds an option to drop the packets when all nexthops for the policy-based routing become unreachable. To configure this option, use the following command:

```
configure flow-redirect <flow-redirect-name> no-active drop
```

Figure 93: Example—Network Diagram



Traffic from the Source IP = 211.10.15.0/24, 211.10.16.0/24 network blocks should be redirected into two routers: 192.168.2.2 and 192.168.2.3. The 192.168.2.2 router is preferred to 192.168.2.3. If router 192.168.2.2 is not reachable, 192.168.2.3 should be used. If both routers are not reachable, the default route is used.

Use the following procedure:

- 1 Create a flow-redirect to keep nexthop IP address and health check information.
 - create flow-redirect premium_subscriber
 - config flow-redirect premium_subscriber add nexthop 192.168.2.2 priority 200
 - config flow-redirect premium_subscriber add nexthop 192.168.2.3 priority 100
- 2 Add an ACL entry with a flow-redirect name action to the existing ACL policy (For example: premium_user.pol).

```
entry premium_15 {
  if match {
    source-address 211.10.15.0/24;
  } then {
    permit;
    redirect-name premium_subscriber;
  }
}

entry premium_16 {
  if match {
    source-address 211.10.16.0/24;
  } then {
    permit;
  }
}
```

```

        redirect-name premium_subscriber;
    }
}

```

- 3** Apply the modified ACL policy file or dynamic ACL into a port, VLAN, or VLAN and Port. (For example: user1 VLAN: 192.168.1.0/30, user2 VLAN: 192.168.1.4/30)

```

config access-list premium_user vlan user1 ingress
config access-list premium_user vlan user2 ingress

```

- 4** Finally, check the current flow-redirect status.

```
BD-8810.47 # show flow-redirect "premium_subscriber"
```

```

Name           : premium_subscriber VR Name          : VR-Default
NO-ACTIVE NH   : FORWARD              HC TYPE         : PING
NH COUNT       : 2                    ACTIVE IP       : 192.168.2.3
Index  STATE   Pri  IP ADDRESS          STATUS INTERVAL MISS
=====
0      ENABLED  200 192.168.2.2          DOWN    2         2
1      ENABLED  100 192.168.2.3          UP      2         2

```

```
BD-8810.48 # show flow-redirect
```

```

Flow-Redirect Name NH_CNT ACTIVE IP      VR Name      D/F  HC
=====
premium_subscriber 2      192.168.2.3  VR-Default  F    PING

```

ACL Troubleshooting

On BlackDiamond 8800 series switches, SummitStack, and Summit family switches, the following commands are designed to help troubleshoot and resolve ACL configuration issues:

```

show access-list usage acl-mask port <port>
show access-list usage acl-range port <port>
show access-list usage acl-rule port <port>
show access-list usage acl-slice port <port>

```

The “acl-mask” keyword is not relevant for the a-series or e-series models. If you enter this command and specify an a-series or e-series port, the following error message appears:

```
This command is not applicable to the specified port.
```

Use the “acl-rule” keyword to display the total number of ACL rules that are available and consumed for the specified port. If this keyword is specified on an a-series or e-series port, the first part of the command output details the port list using this resource because the ACL hardware rules are shared by all ports on a given ASIC (24x1G ports). If you enter the same command and specify any of the listed ports, the command output is identical.

```

*switch # show access-list usage acl-rule port 4:1 Ports 4:1-4:12, 4:25-4:36
Total Rules:      Used: 46  Available: 2002

```

The “acl-slice” keyword is used to display ACL resource consumption for each of the independent TCAMs, or slices, that make up the hardware ACLs. Each slice is a 128-entry TCAM. The command output displays the number of consumed and available TCAM rules for each slice as follows.

```
*switch # show access-list usage acl-slice port 4:1
```

```
Ports 4:1-4:12, 4:25-4:36
Slices:           Used: 8 Available: 8
Slice 0 Rules:    Used: 1 Available: 127
Slice 1 Rules:    Used: 1 Available: 127
Slice 2 Rules:    Used: 1 Available: 127
Slice 3 Rules:    Used: 8 Available: 120
Slice 4 Rules:    Used: 8 Available: 120
Slice 5 Rules:    Used: 2 Available: 126
Slice 6 Rules:    Used: 1 Available: 127
Slice 7 Rules:    Used: 24 Available: 104
```

Use the “acl-range” keyword to view the Layer-4 port range hardware resource on an a-series or e-series model switch. Each a-series and e-series ASIC has 16 Layer-4 port range checkers that are shared among the 24 1G ports. The first part of the command output lists the ports that utilizes this resource. The second part of the command output lists the number of range checkers that are consumed and the number available for use.

```
switch # show access-list usage acl-range port 4:1
Ports 4:1-4:12, 4:25-4:36
L4 Port Ranges:  Used: 0 Available: 16
```

If the “acl-slice” or “acl-range” keyword is specified with an e-series port, the following error message will appear:

```
This command is not applicable to the specified port.
```


19

CHAPTER

Routing Policies

This chapter includes the following sections:

- [Overview on page 717](#)
- [Routing Policy File Syntax on page 718](#)
- [Applying Routing Policies on page 722](#)
- [Policy Examples on page 723](#)

Overview

Routing policies are used to control the advertisement or recognition of routes communicated by routing protocols, such as Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Intermediate System-Intermediate System (IS-IS) and Border Gateway Protocol (BGP). Routing policies can be used to “hide” entire networks or to trust only specific sources for routes or ranges of routes. The capabilities of routing policies are specific to the type of routing protocol involved, but these policies are sometimes more efficient and easier to implement than access lists.

Routing policies can also modify and filter routing information received and advertised by a switch.

A similar type of policy is an ACL policy, used to control, at the hardware level, the packets accessing the switch. ACL policy files and routing policy files are both handled by the policy manager and the syntax for both types of files is checked by the policy manager.



NOTE

Although ExtremeXOS does not prohibit mixing ACL and routing type entries in a policy file, it is strongly recommended that you do not mix the entries, and you use separate policy files for ACL and routing policies.

Routing Policy File Syntax

A routing policy file contains one or more policy rule entries. Each routing policy entry consists of:

- A policy entry rule name, unique within the same policy.
- Zero or one match type. If no type is specified, the match type is all, so all match conditions must be satisfied.
- Zero or more match conditions. If no match condition is specified, then every routing entity matches.
- Zero or more actions. If no action is specified, the packet is permitted by default.

Each policy entry in the file uses the following syntax:

```
entry <routingrulename>{
  if <match-type> {
    <match-conditions>;
  } then {
    <action>;
  }
}
```

The following is an example of a policy entry:

```
entry ip_entry {
  if match any {
    nlri 10.203.134.0/24;
    nlri 10.204.134.0/24;
  } then {
    next-hop 192.168.174.92;
    origin egp;
  }
}
```

Policy entries are evaluated in order, from the beginning of the file to the end, as follows:

- If a match occurs, the action in the *then* statement is taken:
 - if the action contains an explicit permit or deny, the evaluation process terminates.
 - if the action does not contain an explicit permit or deny, the action is an implicit permit, and the evaluation process terminates.
- If a match does not occur, the next policy entry is evaluated.
- If no match has occurred after evaluating all policy entries, the default action is deny.

Often a policy has a rule entry at the end of the policy with no match conditions. This entry matches anything not otherwise processed, so that the user can specify an action to override the default deny action.

Policy match type, match conditions and action statements are discussed in the following sections:

- [Policy Match Type on page 719](#)
- [Policy Match Conditions on page 719](#)
 - [Autonomous system expressions on page 720](#)
- [Policy Action Statements on page 721](#)

Policy Match Type

The two possible choices for the match type are:

- match all—All the match conditions must be true for a match to occur. This is the default.
- match any—If any match condition is true, then a match occurs.

Policy Match Conditions

Table 82 lists the possible policy entry match conditions.

Table 82: Policy Match Conditions

Match Condition	Description
as-path [<as-number> <as-path-regular-expression>];	Where <as-number> is a valid 2-byte AS number in the range of 1 to 65535 or a 4-byte AS number in the range of 65536 to 4294967294. Where <as-path-regular-expression> is a multi-character regular expression (with 2-byte unsigned Integer being an Atom). Regular expression will consist of the AS-Numbers and various regular expression symbols. Regular expressions must be enclosed in double quotes ("").
community [no-advertise no-export no-export-subconfed number <community_num> <community_regular_expression> <as_num> : <num>];	Where no-advertise, no-export and no-export-subconfed are the standard communities defined by RFC. <community_num> is a four-byte unsigned integer, <as_num> is a two-byte or four-byte AS-Number and <num> is the 2-bytes community number. Community regular expression is a multi-character regular expression (with four byte unsigned integer being an Atom). Regular expression is enclosed in double quotes ("").
med <number>;	Where <number> is a 4-byte unsigned integer.
next-hop [<ipaddress> <ipaddress-regular-expression>];	Where <ipaddress> is a valid IP address in dotted decimal format.
nlri [<ipaddress> any]/<mask-length> {exact}; nlri [<ipaddress> any] mask <mask> {exact}; nlri [<ipv6address> any-ipv6]/<mask-length> {exact};	Where <ipaddress> and <mask> are IPv4 addresses and masks, <mask-length> is an integer with maximum value of 32 for IPv4 addresses. The keyword any matches any IPv4 address with a given (or larger) mask/mask-length. Similarly <ipv6address> is an IPv6 address and <mask-length> is an integer with a maximum value of 128 for IPv6 addresses. The keyword any-ipv6 matches any IPv6 address with a given (or larger) mask-length.
origin [igp egp incomplete];	Where igp, egp and incomplete are the Border Gateway Protocol (BGP) route origin values.
tag <number>;	Where <number> is a 4-byte unsigned number.
route-origin [direct static icmp egp ggp hello rip isis esis cisco-igrp ospf bgp idrp dvmrp mospf pim-dm pim-sm ospf-intra ospf-inter ospf-extern1 ospf-extern2 bootp e-bgp i-bgp mbgp i-mbgp e-mbgp isis-level-1 isis-level-2 isis-level-1-external isis-level-2-external]	Matches the origin (different from BGP route origin) of a route. A match statement "route-origin bgp" will match routes whose origin are "I-bgp" or "e-bgp" or "I-mbgp" or "e-mbgp". Similarly, the match statement "route-origin ospf" will match routes whose origin is "ospf-inta" or "ospf-inter" or "ospf-as-external" or "ospf-extern-1" or "ospf-extern-2"

**NOTE**

When entering an AS number in a policy file, you must enter a unique 2-byte or 4-byte AS number. The transition AS number, AS 23456, is not supported in policy files.

Autonomous system expressions

The `AS-path` keyword uses a regular expression string to match against the autonomous system (AS) path. [Table 83](#) lists the regular expressions that can be used in the match conditions for Border Gateway Path (BGP) AS path and community. [Table 84](#) shows examples of regular expressions and the AS paths they match.

Table 83: AS Regular Expression Notation

Character	Definition
N	As number
$N_1 - N_2$	Range of AS numbers, where N_1 and N_2 are AS numbers and $N_1 < N_2$
$[N_x \dots N_y]$	Group of AS numbers, where N_x and N_y are AS numbers or a range of AS numbers
$[\^N_x \dots N_y]$	Any AS numbers other than the ones in the group
.	Matches any number
^	Matches the beginning of the AS path
\$	Matches the end of the AS path
-	Matches the beginning or end, or a space
-	Separates the beginning and end of a range of numbers
*	Matches 0 or more instances
+	Matches 1 or more instances
?	Matches 0 or 1 instance
{	Start of AS SET segment in the AS path
}	End of AS SET segment in the AS path
(Start of a confederation segment in the AS path
)	End of a confederation segment in the AS path

Table 84: Policy Regular Expression Examples

Attribute	Regular Expression	Example Matches
AS path is 64496	"64496"	64496
Zero or more occurrences of AS number 1234	"64496*"	64496 64496 64496
Start of AS path set	"64496 64500 { 64505"	64496 64500 64505 { 64511 64509 64496 64500 { 64505 64507
End of AS path set	"64500 } 64505"	64500 } 64505 56
Path that starts with 99 followed by 34	"^64511 64505 "	64511 64505 45
Path that ends with 99	"64511 \$"	45 66 64511

Table 84: Policy Regular Expression Examples (Continued)

Attribute	Regular Expression	Example Matches
Path of any length that begins with AS numbers 64496 64497 64498	"64496 64497 64498 .*"	64496 64497 64498 64499 64500 64501 64502 64503 64504
Path of any length that ends with AS numbers 64496 64497 64498	".* 64496 64497 64498 \$"	64496 64497 64498 64502 64503 64504 64496 64497 64498

Following are additional examples of using regular expressions in the AS-Path statement.

The following AS-Path statement matches AS paths that contain only (begin and end with) AS number 64511:

```
as-path "^64511$"
```

The following AS-Path statement matches AS paths beginning with AS number 64500, ending with AS number 64511, and containing no other AS paths:

```
as-path "^64500 64511$"
```

The following AS-Path statement matches AS paths beginning with AS number 64496, followed by any AS number from 65500 - 65505, and ending with either AS number 65507, 65509, or 65511:

```
as-path "^64496 65500-65505 [65507 65509 65511]$"
```

The following AS-Path statement matches AS paths beginning with AS number 65511 and ending with any AS number from 65500 - 65505:

```
as-path "65511 [65500-65505]$"
```

The following AS-Path statement matches AS paths beginning with AS number 65511 and ending with any additional AS number, or beginning and ending with AS number 65511:

```
as-path "65511 .?"
```

Policy Action Statements

Table 85 lists policy action statements. These are the actions taken when the policy match conditions are met in a policy entry.

Table 85: Policy Actions

Action	Description
as-path "<as_num> {<as_num1> <as_num2> <as_num3> <as_numN>}";	Prepends the entire list of as-numbers to the as-path of the route.
community set [no-advertise no-export no-export-subconfed <community_num> {<community_num1> <community_num2> <community_numN>} <as_num> : <community_num> [<as_num1> <community_num1> <as_num2> <community_num2>]];	Replaces the existing community attribute of a route by the communities specified by the action statement. Communities must be enclosed in double quotes ("").

Table 85: Policy Actions (Continued)

Action	Description
community [add delete] [no-advertise no-export no-export-subconfed <community_num> {<community_num1> <community_num2> <community_numN>} <as_num> : <community_num> {<as_num1> <community_num1> <as_num2> <community_num2>}];	Adds/deletes communities to/from a route's community attribute. Communities must be enclosed in double quotes ("").
community remove;	Strips off the entire community attribute from a route. Communities must be enclosed in double quotes ("").
cost <cost(0-4261412864)>;	Sets the cost/metric for a route.
cost-type {ase-type-1 ase-type-2 external internal};	Sets the cost type for a route.
dampening half-life <minutes (1-45)> reuse-limit <number (1-20000)> suppress-limit <number (1-20000)> max-suppress <minutes (1-255)>;	Sets the BGP route flap dampening parameters.
deny;	Denies the route.
local-preference <number>;	Sets the BGP local preference for a route.
med {add delete} <number>;	Performs MED arithmetic. Add means the value of the MED in the route will be incremented by <number>, and delete means the value of the MED in the route will be decremented by <number>.
med {internal remove};	Internal means that the Interior Gateway Protocol (IGP) distance to the next hop will be taken as the MED for a route. Remove means take out the MED attribute from the route.
med set <number>;	Sets the MED attribute for a route.
next-hop <ipv4 address ipv6 address>;	Sets the next hop attribute for a route.
nlri [<ipaddress> any]/<mask-length> {exact}; nlri [<ipaddress> any] mask <mask> {exact};	These set statements are used for building a list of IP addresses. This is used by PIM to set up the RP list.
origin {igp egp incomplete};	Sets the BGP route origin values.
permit;	Permits the route.
tag <number>;	Sets the tag number for a route.
weight <number>	Sets the weight for a BGP route.

Applying Routing Policies

To apply a routing policy, use the command appropriate to the client. Different protocols support different ways to apply policies, but there are some generalities.

Commands that use the keyword `import-policy` are used to change the attributes of routes installed into the switch routing table by the protocol. These commands cannot be used to determine the routes to be added to the routing table. The following are examples for the BGP and RIP protocols:

```
configure bgp import-policy [<policy-name> | none]
configure rip import-policy [<policy-name> | none]
```

Commands that use the keyword `route-policy` control the routes advertised or received by the protocol. For BGP and RIP, here are some examples:

```
configure bgp neighbor [<remoteaddr> | all] {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} route-policy [in | out] [none | <policy>]
configure bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} route-policy [in | out] [none | <policy>]
configure rip vlan [<vlan-name> | all] route-policy [in | out] [<policy-name> | none]
```

Other examples of commands that use routing policies include:

```
configure ospf area <area-identifier> external-filter [<policy-map> | none]
configure ospf area <area-identifier> interarea-filter [<policy-map> | none]
configure rip vlan [<vlan-name> | all] trusted-gateway [<policy-name> | none]
```

To remove a routing policy, use the `none` option in the command.

Policy Examples

The following sections contain examples of policies. The examples are:

- [Translating an access profile to a policy on page 723](#)
- [Translating a Route Map to a Policy on page 725](#)

Translating an access profile to a policy

You may be more familiar with using access profiles on other Extreme Networks switches. This example shows the policy equivalent to an ExtremeWare access profile.

ExtremeWare Access-Profile:

Seq_No	Action	IP Address	IP Mask	Exact
5	permit	22.16.0.0	255.252.0.0	No
10	permit	192.168.0.0	255.255.192.0	Yes
15	deny	any	255.0.0.0	No
20	permit	10.10.0.0	255.255.192.0	No
25	deny	22.44.66.0	255.255.254.0	Yes

Equivalent ExtremeXOS policy map definition:

```
entry entry-5 {
  If {
    nlri 22.16.0.0/14;
  }
  then {
    permit;
  }
}

entry entry-10 {
  if {
    nlri 192.168.0.0/18 exact;
  }
  then {
    permit;
  }
}
```

```
}  
  
entry entry-15 {  
    if {  
        nlri any/8;  
    }  
    then {  
        deny;  
    }  
}  
  
entry entry-20 {  
    if {  
        nlri 10.10.0.0/18;  
    }  
    then {  
        permit;  
    }  
}  
  
entry entry-25 {  
    if {  
        nlri 22.44.66.0/23 exact;  
    }  
    then {  
        deny;  
    }  
}
```

The policy above can be optimized by combining some of the if statements into a single expression. The compact form of the policy looks like this:

```
entry permit_entry {  
    If match any {  
        nlri 22.16.0.0/14;  
        nlri 192.168.0.0/18 exact ;  
        nlri 10.10.0.0/18;  
    }  
    then {  
        permit;  
    }  
}  
  
entry deny_entry {  
    if match any {  
        nlri any/8;  
        nlri 22.44.66.0/23 exact;  
    }  
    then {  
        deny;  
    }  
}
```

Translating a Route Map to a Policy

You may be more familiar with using route maps on other Extreme Networks switches. This example shows the policy equivalent to an ExtremeWare route map.

ExtremeWare route map:

```
Route Map : rt
  Entry : 10      Action : permit
    match origin incomplete
  Entry : 20      Action : deny
    match community 6553800
  Entry : 30      Action : permit
    match med 30
    set next-hop 10.201.23.10
    set as-path 64502
    set as-path 64503
    set as-path 64504
    set as-path 64504
  Entry : 40      Action : permit
    set local-preference 120
    set weight 2
  Entry : 50      Action : permit
    match origin incomplete
    match community 19661200
    set dampening half-life 20 reuse-limit 1000 suppress-limit 3000 max-suppress
40
  Entry : 60      Action : permit
    match next-hop 192.168.1.5
    set community add 949616660
```

Equivalent policy:

```
entry entry-10 {
  If {
    origin    incomplete;
  }
  then {
    permit;
  }
}

entry entry-20 {
  if {
    community 6553800;
  }
  then {
    deny;
  }
}

entry entry-30 {
  if {
    med    30;
  }
}
```

```
    then {
      next-hop 10.201.23.10;
      as-path 64502;
      as-path 64503;
      as-path 64504;
      as-path 64504;
      permit;
    }
  }

entry entry-40 {
  if {

  }
  then {
    local-preference 120;
    weight 2;
    permit;
  }
}

entry entry-50 match any {
  if {
    origin incomplete;
    community 19661200;
  }
  then {
    dampening half-life 20 reuse-limit 1000 suppress-limit 3000 max-suppress 40
    permit;
  }
}

entry entry-60 {
  if {
    next-hop 192.168.1.5;
  }
  then {
    community add 949616660;
    permit;
  }
}

entry deny_rest {
  if {

  }
  then {
    deny;
  }
}
```

20 QoS

CHAPTER

This chapter includes the following sections:

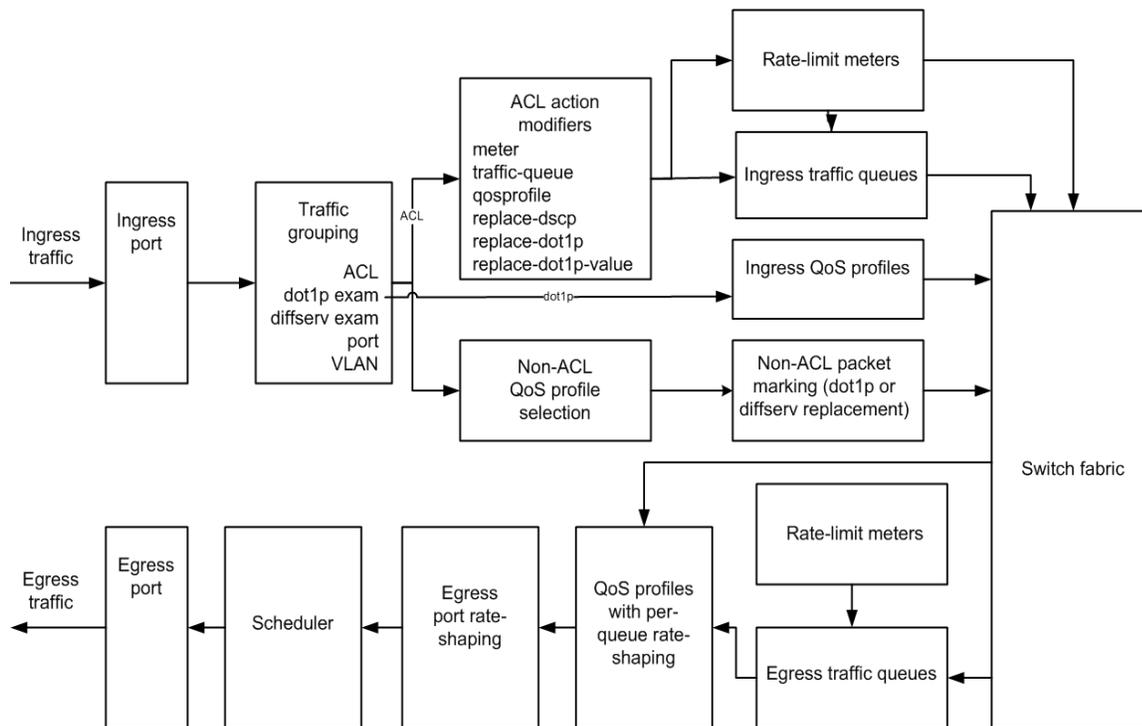
- [Overview Appendix A, “Feature License Requirements.” on page 727](#)
- [Configuring QoS on page 743](#)
- [Displaying QoS Configuration and Performance on page 757](#)

Overview [Appendix A, “Feature License Requirements.”](#)

Quality of Service (QoS) is a feature that allows you to configure a switch to provide different levels of service to different groups of traffic. For example, QoS allows you to do the following:

- Give some traffic groups higher priority access to network resources
- Reserve bandwidth for special traffic groups
- Restrict some traffic groups to bandwidth or data rates defined in a Service Level Agreement (SLA)
- Count frames and packets that exceed specified limits and optionally discard them (rate limiting)
- Queue or buffer frames and packets that exceed specified limits and forward them later (rate shaping)
- Modify QoS related fields in forwarded frames and packets (remark)

[Figure 94](#) shows the QoS components that provide these features on Extreme Networks switches.

Figure 94: QoS on Extreme Networks Switches

In [Figure 94](#), data enters the ingress port and is sorted into traffic groups, which can be classified as either access control list (ACL)-based or nonACL-based. The ACL-based traffic groups provide the most control of QoS features and can be used to apply ingress and egress rate limiting and rate shaping as follows:

- Subject ingress traffic to rate limit meters
- Specify ingress hardware queues (QoS profiles) for rate limiting and rate shaping
- Specify ingress software traffic queues for rate limiting and rate shaping (these can be associated with egress traffic queues for additional QoS control)
- Specify egress software traffic queues for rate limiting and rate shaping
- Specify egress QoS profiles for rate limiting and rate shaping
- Change the dot1p or Differential Services (DiffServ) values in egress frames or packets

NonACL-based traffic groups specify an ingress or egress QoS profile for rate limiting and rate shaping. These groups cannot use ingress or egress software traffic queues. However, nonACL-based traffic groups can use the packet marking feature to change the dot1p or DiffServ values in egress frames or packets.

The ingress rate-limiting and rate-shaping features allow you to apply QoS to incoming traffic before it reaches the switch fabric. If some out-of-profile traffic needs to be dropped, it is better to drop it before it consumes resources in the switch fabric.

All ingress traffic is linked to an egress traffic queue or QoS profile before it reaches the switch fabric. This information is forwarded with the traffic to the egress interface, where it selects the appropriate egress traffic queue or QoS profile. Egress traffic from all traffic queues and QoS profiles is forwarded to the egress port rate-shaping feature, which applies QoS to the entire port. When multiple QoS profiles are contending for egress bandwidth, the scheduler determines which queues are serviced.

The following sections provide more information on QoS:

- [Applications and Types of QoS on page 729](#)
- [Traffic Groups on page 731](#)
- [Introduction to Rate Limiting, Rate Shaping, and Scheduling on page 735](#)
- [Introduction to WRED on page 738](#)
- [Meters on page 739](#)
- [QoS Profiles on page 740](#)
- [Multicast, broadcast, and flooded traffic flows for QP5-8 share a single multicast queue and are prioritized equally with the other traffic flows from QP1-8. Extreme Networks recommends that you do not direct multicast flows to QP5-8. on page 742](#)
- [Multicast Traffic Queues on page 743](#)
- [Egress Port Rate Limiting and Rate Shaping on page 743](#)

Applications and Types of QoS

Different applications have different QoS requirements. [Table 86](#) summarizes the QoS guidelines for different types of network traffic.

Table 86: Traffic Type and QoS Guidelines

Traffic type	Key QoS parameters
Voice	Minimum bandwidth, priority
Video	Medium bandwidth, priority, buffering (varies)
Database	Minimum bandwidth
Web browsing	Minimum bandwidth for critical applications, maximum bandwidth for noncritical applications
File server	Minimum bandwidth

Consider the guidelines in [Table 86](#) as general guidelines and not as strict recommendations. After QoS parameters have been set, you can monitor the performance of the application to determine if the actual behavior of the applications matches your expectations. It is very important to understand the needs and behavior of the particular applications you want to protect or limit. Behavioral aspects to consider include bandwidth needs, sensitivity to latency and jitter, and sensitivity and impact of packet loss.



NOTE

Full-duplex links should be used when deploying policy-based QoS. Half-duplex operation on links can make delivery of guaranteed minimum bandwidth impossible.

The following sections provide more information on the traffic types listed in [Table 86](#):

- [Voice Applications on page 730](#)
- [Video Applications on page 730](#)
- [Critical Database Applications on page 730](#)
- [Web Browsing Applications on page 730](#)
- [File Server Applications on page 730](#)

Voice Applications

Voice applications, or voice over IP (VoIP), typically demand small amounts of bandwidth. However, the bandwidth must be constant and predictable because voice applications are typically sensitive to latency (inter-packet delay) and jitter (variation in inter-packet delay). The most important QoS parameter to establish for voice applications is minimum bandwidth, followed by priority.

Video Applications

Video applications are similar in needs to voice applications, with the exception that bandwidth requirements are somewhat larger, depending on the encoding. It is important to understand the behavior of the video application being used. For example, in the playback of stored video streams, some applications can transmit large amounts of data for multiple streams in one *spike*, with the expectation that the end stations will buffer significant amounts of video-stream data. This can present a problem to the network infrastructure, because the network must be capable of buffering the transmitted spikes where there are speed differences (for example, going from gigabit Ethernet to Fast Ethernet). Key QoS parameters for video applications include minimum bandwidth and priority, and possibly buffering (depending upon the behavior of the application).

Critical Database Applications

Database applications, such as those associated with Enterprise Resource Planning (ERP), typically do not demand significant bandwidth and are tolerant of delay. You can establish a minimum bandwidth using a priority less than that of delay-sensitive applications.

Web Browsing Applications

QoS needs for Web browsing applications cannot be generalized into a single category. For example, ERP applications that use a browser front-end might be more important than retrieving daily news information. Traffic groupings can typically be distinguished from each other by their server source and destinations. Most browser-based applications are distinguished by the dataflow being asymmetric (small dataflows from the browser client, large dataflows from the server to the browser client).

An exception to this might be created by some Java™-based applications. In addition, Web-based applications are generally tolerant of latency, jitter, and some packet loss; however, small packet loss might have a large impact on perceived performance because of the nature of TCP. The relevant parameter for protecting browser applications is minimum bandwidth. The relevant parameter for preventing non-critical browser applications from overwhelming the network is maximum bandwidth.

File Server Applications

With some dependencies on the network operating system, file serving typically poses the greatest demand on bandwidth, although file server applications are very tolerant of latency, jitter, and some packet loss, depending on the network operating system and the use of TCP or UDP.

Traffic Groups

A traffic group defines the ingress traffic to which you want to apply some level of QoS. You can use the ExtremeXOS software to define traffic groups based on the following:

- Frame or packet header information such as IP address or MAC address
- Class of Service (CoS) 802.1p bits in the frame header
- DiffServ information in a packet header
- Ingress port number
- VLAN ID

Traffic groups that are defined based on frame or packet information are usually defined in Access Control Lists (ACLs). The exception to this rule is the CoS and DiffServ information, which you can use to define traffic groups without ACLs.

The function of the CoS and DiffServ traffic groups is sometimes referred to as *explicit packet marking*, and it uses information contained within a frame or packet to explicitly determine a class of service. An advantage of explicit packet marking is that the class of service information can be carried throughout the network infrastructure, without repeating what can be complex traffic group policies at each switch location. Another advantage is that end stations can perform their own packet marking on an application-specific basis. Extreme Networks switch products have the capability of observing and manipulating packet marking information with no performance penalty.

The CoS and DiffServ capabilities (on supported platforms) are not impacted by the switching or routing configuration of the switch. For example, 802.1p information can be preserved across a routed switch boundary and DiffServ code points can be observed or overwritten across a Layer 2 switch boundary.

During QoS configuration, you configure the QoS level first by configuring QoS profiles, traffic queues, and meters, and then you define a traffic group and assign the traffic group to the QoS configuration. The following sections provide additional information on the traffic groups you can define:

- [ACL-Based Traffic Groups on page 731](#)
- [CoS 802.1p-Based Traffic Groups on page 732](#)
- [DiffServ-Based Traffic Groups on page 733](#)
- [Port-Based Traffic Groups on page 734](#)
- [VLAN-Based Traffic Groups on page 735](#)
- [Precedence of Traffic Groups on page 735](#)

ACL-Based Traffic Groups

An ACL-based traffic group allows you to use ACL rules in an ACL policy file to define the traffic to which you want to apply QoS. An ACL-based traffic group requires more effort to create, but the ACL rules give you more control over which traffic is selected for the traffic group. For example, you can use an ACL to add traffic to a traffic group based on the following frame or packet components:

- MAC source or destination address
- Ethertype
- IP source or destination address
- IP protocol
- TCP flag

- TCP, UDP, or other Layer 4 protocol
- TCP or UDP port information
- IP fragmentation

Depending on the platform you are using, traffic in an ACL traffic group can be processed as follows:

- Assigned to an ingress meter for rate limiting
- Marked for an egress QoS profile for rate shaping
- Marked for an egress traffic queue for rate shaping
- Marked for DSCP replacement on egress
- Marked for 802.1p priority replacement on egress
- Assigned to an egress meter for rate limiting

When you are deciding whether to use an ACL-based traffic group or another type of traffic group, consider what QoS features you want to apply to the traffic group. Some QoS features can only apply to ACL-based traffic groups.



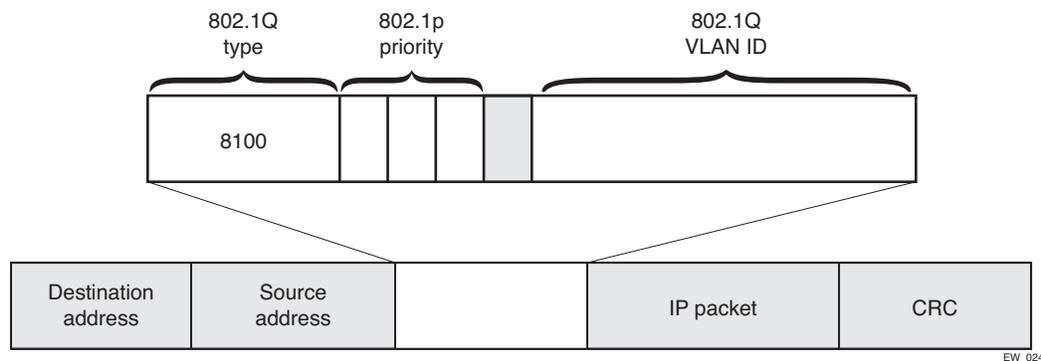
NOTE

ACLs are discussed in detail in [Chapter 18, “ACLs.”](#)

CoS 802.1p-Based Traffic Groups

CoS 802.1p-based traffic groups forward traffic to QoS features based on the three 802.1p priority bits in an Ethernet frame. The 802.1p priority bits are located between the 802.1Q type field and the 802.1Q VLAN ID as shown in [Figure 95](#).

Figure 95: 802.1p Priority Bits



The three 802.1p priority bits define up to 8 traffic groups that are predefined in the ExtremeXOS software.

On BlackDiamond X8, 8800, SummitStack, and Summit family switches, the traffic groups direct traffic to egress QoS profiles for egress rate shaping (see [Table 89](#)).



NOTE

See [Chapter 13, "VMAN \(PBN\) and PBBN,"](#) for information regarding VMANs using 802.1p information to direct frames to appropriate egress QoS queues.

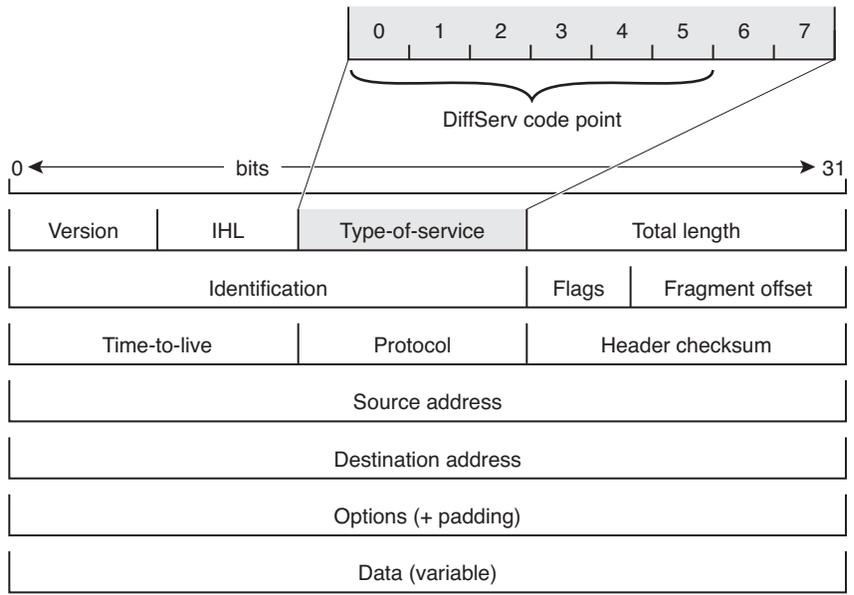
You do not need to define 802.1p-based traffic groups. You can enable or disable the use of these traffic groups by enabling or disabling the *802.1p examination* feature. You can also configure which 802.1p values map to which QoS profiles.

A related feature is the 802.1p replacement feature, which allows you to configure the software to replace the 802.1p bits in an ingress frame with a different value in the egress frame. For more information on 802.1p replacement, see ["Configuring 802.1p or DSCP Replacement" on page 746.](#)

DiffServ-Based Traffic Groups

DiffServ-based traffic groups forward traffic to egress QoS profiles based on the type-of-service (TOS) or traffic class (TC) information in an IP packet. In many systems, this TOS or TC information is replaced with a DiffServ field that uses 6 of the 8 bits for a DiffServ code point (DSCP) as shown in [Figure 96.](#) (The other two bits are not used.)

Figure 96: DiffServe Code Point



Because the DSCP uses six bits, it has 64 possible values ($2^6 = 64$). By default, the values are grouped and assigned to the default QoS profiles as listed in [Table 87.](#)

Table 87: Default DSCP-to-QoS-Profile Mapping

Traffic Group Code Point	BlackDiamond 8800 Series Switches, SummitStack, and Summit Family Switches QoS Profile
0-7	QP1
8-15	QP1

Table 87: Default DSCP-to-QoS-Profile Mapping (Continued)

Traffic Group Code Point	BlackDiamond 8800 Series Switches, SummitStack, and Summit Family Switches QoS Profile
16-23	QP1
24-31	QP1
32-39	QP1
40-47	QP1
48-55	QP1
56-63	QP8

**NOTE**

The default DiffServ examination mappings apply on ports in more than one VR. If you attempt to configure DiffServ examination or replacement on a port that is in more than one virtual router, the system returns the following message:

```
Warning: Port belongs to more than one VR. Port properties related to diff serv and
code replacement will not take effect.
```

You do not need to define these traffic groups. You can enable or disable the use of these traffic groups by enabling or disabling the *DiffServ examination* feature as described in [“Configuring a DiffServ-Based Traffic Group” on page 753](#). You can also configure which DSCP values map to which queues.

**NOTE**

When DiffServ examination is enabled on 1 Gigabit Ethernet ports for BlackDiamond 8800 series switches, SummitStack, and Summit family switches, 802.1p replacement is enabled and cannot be disabled. The ingress 802.1p value is replaced with the 802.1p value assigned to the egress QoS profile.

A related feature is the DiffServ replacement feature, which allows you to configure the software to replace the DSCP in an ingress frame with a different value in the egress frame. For more information on DiffServ replacement, see [“Configuring 802.1p or DSCP Replacement” on page 746](#).

Port-Based Traffic Groups

Port-based traffic groups forward traffic to egress QoS profiles based on the incoming port number. There are no default port-based traffic groups. You must configure each port-based traffic group.

**NOTE**

On BlackDiamond X8 series switches, BlackDiamond 8800 series switches, SummitStack, and Summit family switches, port-based traffic groups apply to all packets.

VLAN-Based Traffic Groups

VLAN-based traffic groups forward traffic to egress QoS profiles based on the VLAN membership of the ingress port. There are no default VLAN-based traffic groups. You must configure each VLAN-based traffic group.



NOTE

On BlackDiamond X8 series switches, BlackDiamond 8800 series switches, SummitStack, and Summit family switches, VLAN-based traffic groups apply to all packets.

Precedence of Traffic Groups

The ExtremeXOS software allows you to define multiple traffic groups, and you can configure traffic groups in such a way that multiple traffic groups apply to an ingress frame or packet. When an ingress frame or packet matches two or more traffic groups, the software chooses one traffic group based on the precedence defined for the switch platform. In general, the more specific traffic group definition takes precedence. [Table 88](#) shows the traffic group precedence for the supported switch platforms (number 1 is the highest precedence).

Table 88: Traffic Group Precedence

BlackDiamond X8 series switches, BlackDiamond 8800 Series Switches, SummitStack, and Summit Family Switches	
1	ACL-based traffic groups for IP packets (specifies IP address information)
2	ACL-based traffic groups for Ethernet frames (specifies MAC address information)
3	CoS 802.1p-based traffic groups
4	Port-based traffic groups
5	VLAN-based traffic groups
6	DiffServ-based traffic groups

Introduction to Rate Limiting, Rate Shaping, and Scheduling

The rate limiting and rate shaping terms are used throughout this chapter to describe QoS features. Some QoS features perform both rate limiting and rate shaping. Rate limiting is the process of restricting traffic to a peak rate (PR). Rate shaping is the process of reshaping traffic throughput to give preference to higher priority traffic or to buffer traffic until forwarding resources become available.

Both rate limiting and rate shaping allow you to take action on traffic that exceeds the configured limits. These actions include forwarding traffic, dropping traffic, and marking the excess traffic for possible drops later in the communication path. Software counters allow you to record traffic statistics such as total packets forwarded and total packets dropped.

The following sections provide general information on rate-limiting and rate-shaping support in the ExtremeXOS software:

- [Single-Rate QoS on page 736](#)
- [Dual-rate QoS on page 736](#)
- [Rate Specification Options on page 737](#)
- [Disabling Rate Limiting and Rate Shaping on page 737](#)
- [Scheduling on page 737](#)

Single-Rate QoS

Single-rate QoS defines a single rate for traffic that is subject to QoS. Single-rate QoS is the most basic form of rate limiting and is well suited for constant rate traffic flows such as video or where more complex dual-rate QoS is not needed. The traffic that meets the rate requirement is considered *in-profile*. Traffic that does not meet the specified rate is considered *out-of-profile*. A two-color system is often used to describe or *mark* the single-rate QoS result. In-profile traffic is marked green, and out-of-profile traffic is marked red.

Single-rate rate-limiters pass traffic that is in-profile or marked green. Out-of-profile traffic (marked red) is subject to whatever action is configured for out-of-profile traffic. Out of profile traffic can be forwarded if bandwidth is available, dropped, or marked for a possible drop later in the communication path.

All traffic that arrives at or below the PR is considered in-profile and marked green. All traffic that arrives above the PR is considered out-of-profile and marked red. When the traffic exceeds the capacity of the rate-limiting component, all traffic that is marked red is dropped.

Another type of single-rate QoS is used on BlackDiamond 8800 switches, SummitStack, and Summit family switches. A committed information rate (CIR) establishes a reserved traffic rate, and a peak burst size (PBS) establishes a maximum size for a traffic stream. If a traffic stream is at or below the CIR and the PBS, it is considered to be within profile and marked green. If a traffic stream exceeds either the CIR or the PBS, it is considered out-of-profile and marked red. On these switches, you can configure the single-rate rate-limiting components to drop traffic marked red or set a drop precedence for that traffic. You can also specify a DSCP value to mark the out-of-profile traffic.

Dual-rate QoS

Dual-rate QoS defines two rates for traffic that is subject to QoS. The lower of the two rates is the CIR, which establishes a reserved traffic rate. The higher of the two rates is the PR, which establishes an upper limit for traffic. Dual-rate QoS is well suited to bursty traffic patterns which are common with typical data traffic. Dual-rate QoS is widely used in legacy Frame Relay and ATM leased lines.



NOTE

You must configure the peak rate higher than the committed rate.

A three-color system is used with dual-rate QoS. As with single-rate QoS, traffic at or below the CIR is considered in-profile, marked green, and forwarded. The traffic that is above the CIR and below the PIR is out-of-profile and marked yellow. Traffic above the PIR is also out-of-profile and marked red. When incoming traffic is already marked yellow and is out of profile, it is marked red. Different switch platforms take different actions on the traffic marked yellow or red.

Rate Specification Options

The ExtremeXOS software allows you to specify the CIR and PR in gigabits per second (Gbps), megabits per second (Mbps), or kilobits per second (Kbps). Most commands also allow you to specify the CIR and PR as a percentage of the maximum port bandwidth using the `minbw` (CIR) and `maxbw` (PR) options. The default value on all minimum bandwidth parameters is 0%, and the default value on all maximum bandwidth parameters is 100%.

QoS can be applied at different locations in the traffic path using the following rate-limiting and rate-shaping components:

- Ingress meters
- Ingress QoS profiles (hardware queues)
- Ingress traffic queues (software queues)
- Egress traffic queues
- Egress meters
- Egress QoS profiles
- Egress ports

The CIR or minimum bandwidth configuration for a rate-limiting or rate-shaping component is a bandwidth guarantee for that component at a particular location in the traffic path. The guarantees for all components at a specified location should add up to less than 100% and should account for the traffic needs of the other components. For example, if you configure 25% minimum bandwidth for four out of eight queues at a particular location, there will be no available bandwidth for the remaining four queues when traffic exceeds the port capacity. Bandwidth unused by a queue can be used by other queues.

The rate-shaping configuration is configured at the location to which it applies on most platforms.

Disabling Rate Limiting and Rate Shaping

All switch platforms provide multiple QoS components in the traffic path that provide rate limiting or rate shaping. These components give you control over where and how the rate shaping is applied. However, your application might not require rate shaping at every component. The default configuration for most components provides no rate shaping. When rate shaping is disabled on a component, the CIR is set to 0 (`minbw=0%`) and the PR is set to the maximum bandwidth (`maxbw=100%`). This setting reserves no bandwidth for the component and allows the component to use 100% of the port bandwidth. If you need to remove rate shaping from a QoS component, configure these settings on that component.

Scheduling

Scheduling is the process that determines which traffic is forwarded when multiple QoS components are competing for egress bandwidth. The ExtremeXOS software supports the following scheduling methods:

- Strict priority queuing: All higher priority queues are serviced before lower priority queues. This ensures that high priority traffic receives access to available network bandwidth immediately, but can result in lower priority traffic being starved. As long as a queued packet remains in a higher-priority queue, any lower-priority queues are not serviced.
- Weighted fair queuing: All queues are given access to a relative amount of bandwidth based on the weight assigned to the queue. When you configure a QoS profile with a weight of 4, that queue is

serviced four times as frequently as a queue with a weight of 1. The hardware services higher-weighted queues more frequently, but lower-weighted queues continue to be serviced at all times. Initially, the weight for all queues is set to 1, which gives them equal weight. If all queues are set to 4, for example, all queues still have equal weight, but each queue is serviced for a longer period.

- Round-robin priority: All queues are given access based on the configured priority level and a round-robin algorithm.

Scheduling takes place on the egress interface and includes consideration for the color-marking of egress frames and packets. Green-marked traffic has the highest priority and is forwarded based on the scheduling method. When multiple queues are competing for bandwidth, yellow-marked traffic might be dropped or remarked red. Red-marked traffic is dropped when no bandwidth is available. If yellow-marked traffic is forwarded to the egress port rate-shaping component, it can be dropped there if the egress port is congested.

Introduction to WRED

The weighted random early detection (WRED) feature is supported on some platforms to avoid congestion in traffic queues or QoS profiles. WRED improves upon the TCP congestion control mechanism.

The TCP congestion control mechanism on hosts detects congestion when packets are lost and lowers the packet transmission rate in response. At the switch, packets are dropped when a queue is full. When multiple hosts forward packets that are dropped, multiple hosts reduce the transmission rate. This creates a global synchronization problem as multiple hosts overwhelm a queue and then simultaneously lower their transmission rate and under utilize the queue.

WRED is an extension to random early detection (RED), which calculates an average queue size and randomly discards packets in proportion to the queue usage. At low usage levels, no packets are discarded. As the average queue size exceeds configured thresholds, packets are discarded in proportion to the queue usage. Discarding packets early causes some (but not all) hosts to reduce their transmission rate, which reduces queue congestion. The random nature of the discard process reduces the global synchronization problem.

WRED extends RED by applying different discard rules for different types of traffic. Typically, WRED is used on core routers and takes action based on the packet contents established at edge routers. Edge routers can use the IP precedence or DSCP value to mark packets as committed (green), conforming (yellow), or exceeded (red). The marking process and these colors are described in [“Introduction to Rate Limiting, Rate Shaping, and Scheduling” on page 735](#).

The ExtremeXOS WRED implementation varies per platform and allows you to configure the following:

- Minimum threshold for dropped packets.
- Maximum threshold for dropped packets.
- Maximum drop rate.
- An average weight control that determines how WRED calculates the average queue size.

WRED does not drop packets at calculated average queue sizes below the minimum threshold (although packets would be dropped if the queue fills). When the calculated average queue size rises above the maximum threshold, WRED drops packets at the maximum drop rate. When the calculated

average falls between the minimum and maximum thresholds, packets are randomly dropped at a proportional rate between 0 and the maximum drop rate. As the queue fills, more packets are dropped.

The average weight parameter provides some control over how the average queue size is calculated and the probability of packet drop. Increasing the `avg_weight` value reduces the probability that traffic is dropped. Conversely, decreasing the `avg_weight` value increases the probability that traffic is dropped.

On BlackDiamond 8900 c- and xl-series modules and Summit X460, X480, and X650 switches, you can configure up to 3 WRED profiles or configurations per QoS profile, enabling you to create custom WRED configurations for up to 24 traffic flows (3 WRED profiles x 8 QoS profiles). Each QoS profile supports WRED profiles for the following colors of traffic:

- TCP green
- TCP red
- Non-TCP any

On BlackDiamond X8 series switches, BlackDiamond 8900 xm-series modules, and Summit X670 switches, you can configure up to 4 WRED profiles or configurations per QoS profile, enabling you to create custom WRED configurations for up to 32 traffic flows (4 WRED profiles x 8 QoS profiles). Each QoS profile supports WRED profiles for the following colors of traffic:

- TCP green
- Non-TCP green
- TCP red
- Non-TCP red

Without support for non-TCP traffic management, non-TCP traffic could monopolize a QoS profile in which TCP traffic is regulated, effectively giving non-TCP traffic priority over TCP traffic. With support for both TCP and non-TCP traffic, WRED allows you to regulate different types of traffic independently, giving you greater control over which type of traffic is dropped first and most frequently.

The typical WRED configuration establishes the lowest probability for packet drop for green traffic, which conforms to established limits along the transmission path. A typical WRED configuration establishes a higher probability for packet drop for red colored traffic, because it has already exceeded established limits earlier in the transmission path. All traffic (green and red) is dropped when the queue is full, so the goal is to configure the WRED settings for each color in such a way as to prevent the queue from filling frequently.

Meters

Meters are used to define ingress rate-limiting and rate-shaping on BlackDiamond 8800 series, SummitStack, and Summit family switches. Some platforms also support meters for egress traffic. The following sections provide information on meters for specific platforms:

- [Meters on BlackDiamond X8 and 8800 Series Switches, SummitStack, and Summit Family Switches on page 739](#)

Meters on BlackDiamond X8 and 8800 Series Switches, SummitStack, and Summit Family Switches. The BlackDiamond X8 and 8800 series switches, SummitStack, and Summit family switches use a single-rate meter to determine if ingress traffic is in-profile or out-of-profile. On BlackDiamond c-, xl-, and xm-series modules and Summit X480, X650, and X670 switches, you can also use single-rate meters to determine if egress traffic is in-profile or out-of-profile.

When ACL meters are applied to a VLAN or to *any*, the rate limit is applied to each port group. To determine which ports are contained within a port group, use any of the following commands:

```
show access-list usage acl-range port <port>
show access-list usage acl-rule port <port>
show access-list usage acl-slice port <port>
```

The out-of-profile actions are drop, set the drop precedence, or mark the DSCP with a configured value. Additionally, each meter has an associated out-of-profile counter that counts the number of packets that were above the committed-rate (and subject to the out-of-profile-action).

On BlackDiamond 8000 series modules and Summit family switches, the meters are a per-chip, per-slice resource (see [Chapter 18, “ACLs,”](#) for complete information.)

. QoS Profiles

QoS profiles are queues that provide ingress or egress rate limiting and rate shaping. The following sections provide more information on QoS profiles:

Egress QoS Profiles

Egress QoS profiles are supported on all ExtremeXOS switches and allow you to provide dual-rate egress rate-shaping for all traffic groups on all egress ports. Any configuration you apply to an egress QoS profile is applied to the same egress QoS profile on all other ports, unless a QoS profile parameter has been overridden for a port.

When you are configuring ACL-based traffic groups, you can use the `qosprofile` action modifier to select an egress QoS profile. For DiffServ-, port-, and VLAN-based traffic groups, the traffic group configuration selects the egress QoS profile. For CoS dot1p traffic groups on all platforms, the dot1p value selects the egress QoS profile.

Egress QoS profile operation depends on the switch type and is described in the following sections:

- [Egress QoS Profiles on BlackDiamond X8 series switches, BlackDiamond 8800 and Summit Family Switches on page 740](#)
- [Egress QoS Profiles on BlackDiamond X8 Series Switches, BlackDiamond 8900 xm-Series Modules, and Summit X670 Series Switches on page 742](#)

Egress QoS Profiles on BlackDiamond X8 series switches, BlackDiamond 8800 and Summit Family Switches. BlackDiamond X8 series switches, BlackDiamond 8800 series switches, SummitStack, and Summit family switches have two default egress QoS profiles named QP1 and QP8. You can configure up to six additional QoS profiles (QP2 through QP7) on the switch. However, on a SummitStack, you cannot create QoS profile QP7, as this profile is reserved for system control traffic. The default settings for egress QoS profiles are summarized in [Table 89](#).

Table 89: Default QoS Profile Parameters on all Platforms

Ingress 802.1p Priority Value	Egress QoS Profile Name ^a	Queue Service Priority Value ^b	Buffer	Weight	Notes
0-6	QP1	1 (Low)	100%	1	This QoS profile is part of the default configuration and cannot be deleted.
	QP2	2 (LowHi)	100%	1	You must create this QoS profile before using it.

Table 89: Default QoS Profile Parameters on all Platforms (Continued)

Ingress 802.1p Priority Value	Egress QoS Profile Name ^a	Queue Service Priority Value ^b	Buffer	Weight	Notes
7	QP3	3 (Normal)	100%	1	You must create this QoS profile before using it.
	QP4	4 (NormalHi)	100%	1	You must create this QoS profile before using it.
	QP5	5 (Medium)	100%	1	You must create this QoS profile before using it.
	QP6	6 (MediumHi)	100%	1	You must create this QoS profile before using it.
	QP7	7 (High)	100%	1	You must create this QoS profile before using it. You cannot create this QoS profile on SummitStack.
	QP8	8 (HighHi)	100%	1	This QoS profile is part of the default configuration and cannot be deleted.

a. The QoS profile name cannot be changed.

b. The queue service priority value cannot be changed.

For CoS 802.1p traffic groups, the ingress 802.1p priority value selects a specific QoS profile as shown in [Table 89](#). This mapping can be changed as described in [“Changing the 802.1p Priority to QoS Profile Mapping” on page 753](#). For traffic groups other than 802.1p-based groups, the traffic group configuration selects a specific egress QoS profile by name.

The default dual-rate QoS configuration is 0% for minimum bandwidth and 100% for maximum bandwidth.

The QoS profile for each port receives a default buffer reservation. All unreserved buffer space is part of a buffer pool, which can be used by QoS profiles when reserved space runs out, provided that the configuration for that QoS profile and port allows it.

You can increase the size of the shared buffer pool by reducing the global buffer reservation for a QoS profile on all switch ports. You can restrict buffer usage for a QoS profile in amounts ranging from 1 to 100%, in whole integers.

You can also override the global buffer reservation to increase or decrease the buffer space allotment for a specific QoS profile on one or more ports. Using the buffer override feature, you can override the global setting to use from 1 to 10,000 percent of the configured global allotment. The system does not drop any packets as long as reserved packet buffer memory for the port and QoS profile or shared packet memory for the port (`configure port shared-packet-buffer` command) remains available.

**NOTE**

In a SummitStack, the scheduling algorithm is automatically programmed by ExtremeXOS for the stacking links only, and might be different from the algorithm you select.

**NOTE**

Use of all eight queues on all ports can result in insufficient buffering to sustain 0 packet loss throughput during full-mesh connectivity with large packets.

When multiple QoS profiles are contending for port bandwidth and the egress traffic in each profile is within profile, the scheduler determines how the QoS profiles are serviced as described in [“Scheduling” on page 737](#). In strict-priority mode, the queues are serviced based on the queue service priority value. In weighted fair-queuing mode, the queues are serviced based on the configured weight.

When configured to do so, the priority of a QoS profile can determine the 802.1p bits used in the priority field of a forwarded frame (see [“Replacing 802.1p Priority Information on Egress” on page 746](#)). The priority of a QoS profile can determine the DiffServ code point value used in an IP packet when the packet is forwarded (see [“Replacing a DSCP on Egress” on page 748](#)).

A QoS profile change does not alter the behavior of the switch until it is assigned to a traffic group.

Egress QoS Profiles on BlackDiamond X8 Series Switches, BlackDiamond 8900 xm-Series Modules, and Summit X670 Series Switches. The egress QoS profiles on BlackDiamond X8 series switches, BlackDiamond 8900 xm-series modules, and Summit X670 series switches operate very similar to those for other BlackDiamond 8000 series modules and Summit family switches. This section describes the behaviors that are unique to the BlackDiamond 8900 xm-series modules and Summit X670 series switches.

The unicast and multicast queues in hardware on BlackDiamond 8900 xm-series modules and Summit X670 series switches are organized differently from other BlackDiamond 8000 series modules and Summit family switches. For optimum use of the QoS profiles on these platforms, Extreme Networks recommends the following:

- Be aware that hardware on these platforms may occasionally reorder packets within a traffic flow.
- Multicast, broadcast, and flooded traffic flows for QP5-8 share a single multicast queue and are prioritized equally with the other traffic flows from QP1-8. Extreme Networks recommends that you do not direct multicast flows to QP5-8.

Multicast Traffic Queues

On BlackDiamond X8, BlackDiamond 8900 xm-series modules, and Summit X670 series switches, multicast, broadcast, and flooded traffic flows for QP5-8 share a single multicast queue and are prioritized equally with the other traffic flows from QP1-8. Extreme Networks recommends that you do not direct multicast flows to QP5-8.

Egress Port Rate Limiting and Rate Shaping

Egress port rate limiting and rate shaping allow you to define limits for all egress traffic coming from the egress QoS profiles and traffic queues. On the BlackDiamond X8 and 8800 series, SummitStack, and Summit family switches, you can apply single-rate rate-limiting and control shared packet buffer space (`configure port shared-packet-buffer` command) for each port. You can also configure ports to pass an unlimited flow as describe in “Disabling Rate Limiting and Rate Shaping” on page 737.

Configuring QoS

The following sections provide information on configuring QoS:

- [Platform Configuration Procedures on page 743](#)
- [Selecting the QoS Scheduling Method on page 745](#)
- [Configuring 802.1p or DSCP Replacement on page 746](#)
- [Configuring Egress QoS Profile Rate Shaping on page 749](#)
- [Configuring Egress Port Rate Limits on page 751](#)
- [Configuring Traffic Groups on page 752](#)
- [Creating and Managing Meters on page 755](#)
- [Adjusting the Byte Count Used to Calculate Traffic Rates on page 756](#)
- [Controlling Flooding, Multicast, and Broadcast Traffic on Ingress Ports on page 756](#)

Platform Configuration Procedures

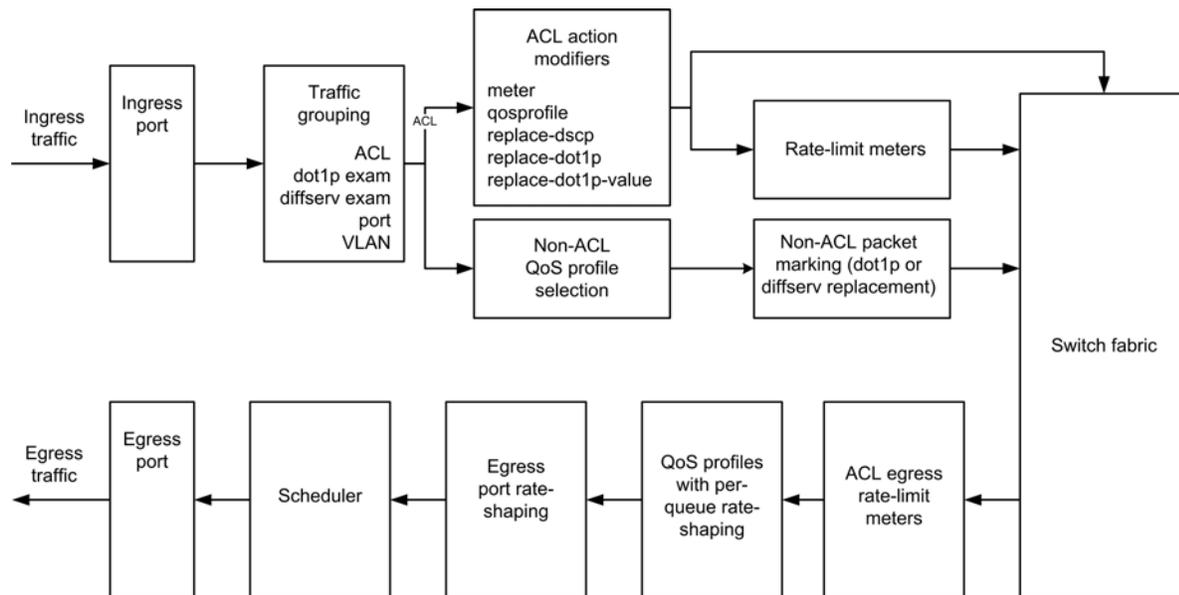
The following sections provide summary configuration procedures for the following platforms:

- [BlackDiamond X8 and 8800, SummitStack, and Summit Family Switches on page 743](#)

BlackDiamond X8 and 8800, SummitStack, and Summit Family Switches

Figure 97 shows the QoS configuration components for BlackDiamond X8 and 8800 series switches, SummitStack, and Summit family switches.

Figure 97: QoS on BlackDiamond X8 and 8800 Series Switches, SummitStack, and Summit Family Switches



The following sections provide information on configuring QoS:

- [QoS Configuration Guidelines for BlackDiamond X8 and 8800, SummitStack, and Summit Family Switches on page 744](#)
- [Configuration Summary for BlackDiamond X8 and 8800, SummitStack, and Summit Family Switches on page 745](#)

QoS Configuration Guidelines for BlackDiamond X8 and 8800, SummitStack, and Summit Family Switches. The following considerations apply only to QoS on the BlackDiamond X8 and 8800 series switches, SummitStack, and Summit family switches:

- The following QoS features share resources:
 - ACLs
 - dot1p
 - VLAN-based QoS
 - Port-based QoS
- You might receive an error message when configuring a QoS feature in the above list; it is possible that the shared resource is depleted. In this case, unconfigure one of the other QoS features and reconfigure the one you are working on.
- On a SummitStack, you cannot create QoS profile QP7. This QoS profile is reserved for system control traffic.
- These switches allow dynamic creation and deletion of QoS queues, with QP1 and QP8 always available.
- ACL egress rate-limit meters are supported only on BlackDiamond c-, xl-, and xm-series modules, and Summit X480, X650, and X670 switches.

Configuration Summary for BlackDiamond X8 and 8800, SummitStack, and Summit Family Switches. Use the following procedure to configure QoS on BlackDiamond X8 and 8800 series switches, SummitStack, and Summit family switches:

- 1 Configure basic Layer 2 connectivity (prerequisite).
- 2 Configure QoS scheduling, if needed, as described in [“Selecting the QoS Scheduling Method” on page 745](#).
- 3 Configure ingress and egress rate-limiting as needed:
 - a Create a meter as described in [“Creating Meters” on page 755](#).
 - b Configure the meter as described in [“Configuring a Meter” on page 755](#).
 - c Apply the meter to ingress traffic as described in [“Applying a Meter to Ingress or Egress Traffic” on page 755](#).
- 4 Configure non-ACL-based egress QoS profile selection as described in the following sections:
 - [Configuring a CoS 802.1p-Based Traffic Group on page 752](#)
 - [Configuring a DiffServ-Based Traffic Group on page 753](#)
 - [Configuring a Port-Based Traffic Group on page 754](#)
 - [Configuring a VLAN-Based Traffic Group on page 755](#)
- 5 Configure 802.1p or DiffServ packet marking as described in [“Configuring 802.1p or DSCP Replacement” on page 746](#).
- 6 Configure egress QoS profile rate shaping as needed:
 - a Create egress QoS profiles as described in [“Creating or Deleting an Egress QoS Profile” on page 750](#).
 - b Configure egress QoS profile rate shaping parameters as described in [“Configuring an Egress QoS Profile” on page 750](#).
- 7 Configure egress port rate shaping as described in [“Configuring Egress Port Rate Limits” on page 751](#).
- 8 Finalize ACL traffic-based group configuration as described in [Configuring an ACL-Based Traffic Group on page 752](#).
- 9 Verify the configuration using the commands described in [“Displaying QoS Configuration and Performance” on page 757](#).

Selecting the QoS Scheduling Method

QoS scheduling determines the order of QoS profile service and varies between platforms. The BlackDiamond X8, BlackDiamond 8800 series switches, SummitStack, and Summit family switches support three scheduling methods: strict-priority, weighted-round-robin, and weighted-deficit-round-robin. These scheduling methods are described in [“Scheduling” on page 737](#). The scheduling applies globally to all ports on the switch, but you can override the weighted-round-robin configuration on a QoS profile.

To select the QoS scheduling method for a switch, use the following command:

```
configure qosscheduler [strict-priority | weighted-round-robin | weighted-deficit-round-robin]
```

**NOTE**

In a SummitStack, the scheduling algorithm is automatically programmed by ExtremeXOS for the stacking links only, and will likely be different than the algorithm you select.

To override the weighted-round-robin switch configuration on a specific QoS profile, use the following command:

```
configure qosprofile <qosprofile> use-strict-priority
```

Configuring 802.1p or DSCP Replacement

The following sections provide information on 802.1p priority replacement and DSCP replacement:

- [Replacing 802.1p Priority Information on Egress on page 746](#)
- [Replacing a DSCP on Egress on page 748](#)
- [DiffServ Example on page 749](#)

Replacing 802.1p Priority Information on Egress

By default, 802.1p priority information is not replaced or manipulated, and the information observed on ingress is preserved when forwarding the frame. This behavior is not affected by the switching or routing configuration of the switch. However, the switch is capable of inserting and/or overwriting 802.1p priority information when it transmits an 802.1Q tagged frame as described in the following sections:

- [Replacement in ACL-Based Traffic Groups on page 746](#)
- [Replacement in Non-ACL-Based Traffic Groups on page 746](#)

Replacement in ACL-Based Traffic Groups. If you are using ACL-based traffic groups, you can use the `replace-dot1p` action modifier to replace the ingress 802.1p priority value with the 802.1p priority value of the egress QoS profile as listed in [Table 90](#). To specify a specific 802.1p priority value on egress, use the `replace-dot1p-value` action modifier.

**NOTE**

If you are using ACL-based traffic groups, you must use ACL action modifiers to replace the 802.1p priority. Traffic that meets any ACL match conditions is not subject to non-ACL-based 802.1p priority replacement.

Replacement in Non-ACL-Based Traffic Groups. For non-ACL-based traffic groups, you can enable or disable 802.1p priority replacement on specific ingress ports. When 802.1p priority replacement is

enabled, the default egress 802.1p priority value is set to the priority value of the egress QoS profile as listed in [Table 90](#).

Table 90: Default Queue-to-802.1p Priority Replacement Value

Egress QoS Profile	802.1p Priority Replacement Value
Q1	0
Q2	1
Q3	2
Q4	3
Q5	4
Q6	5
Q7 ^a	6
Q8	7

- a. You cannot direct traffic to this QoS profile in a SummitStack.

To enable 802.1p priority replacement on egress, use the following command:

```
enable dot1p replacement ports [<port_list> | all]
```



NOTE

The port in this command is the ingress port.

To disable this feature, use the following command:

```
disable dot1p replacement ports [<port_list> | all]
```



NOTE

If CoS 802.1p-based traffic groups are the only type of traffic group enabled, you cannot disable dot1p replacement. When no other traffic groups are configured, CoS 802.1p-based traffic groups replace 802.1p values as shown in [Table 90](#). If only DiffServ traffic groups are enabled, then 802.1p priority enforcement for 802.1q tagged packets continues for non-IP packets using the default 802.1p map shown in [Table 90](#).



NOTE

On the BlackDiamond X8 series switches, BlackDiamond 8800 series switches, SummitStack, and Summit family switches, only QP1 and QP8 exist by default; you must create QP2 to QP7 (QP2 to QP5 in a SummitStack). If you have not created these QPs, the replacement feature will not take effect.



NOTE

When DiffServ examination is enabled on 1 Gigabit Ethernet ports for BlackDiamond 8800 series switches, SummitStack, and Summit family switches, 802.1p replacement is enabled and cannot be disabled. The ingress 802.1p value is replaced with the 802.1p value assigned to the egress QoS profile.

Replacing a DSCP on Egress

The switch can be configured to change the DSCP in a packet before forwarding the packet. This is done with no impact on switch performance and can be configured as described in the following sections:

- [Replacement in ACL-Based Traffic Groups on page 746](#)
- [Replacement in Non-ACL-Based Traffic Groups on page 746](#)

Replacement in ACL-Based Traffic Groups. If you are using ACL-based traffic groups, you can use the `replace-dscp` action modifier to replace the ingress DSCP value with the DSCP value of the egress QoS profile as listed in [Table 91](#). This action modifier functions for both IPv4 and IPv6 traffic.



NOTE

If you are using ACL-based traffic groups, you must use ACL action modifiers to replace the DSCP. Traffic that meets any ACL match conditions is not subject to non-ACL-based DSCP priority replacement. For all platforms Extreme Networks recommends that you use ACL-based traffic groups when configuring DSCP replacement.

Replacement in Non-ACL-Based Traffic Groups. For non-ACL-based traffic groups, you can enable or disable DSCP replacement on specific ingress ports. When DSCP replacement is enabled, the DSCP value used on egress is determined by either the QoS profile or the 802.1p priority value. [Table 91](#) shows the default mappings of QoS profiles and 802.1p priority values to DSCPs.

Table 91: Default QoS Profile and 802.1p Priority Value Mapping to DiffServ Code Points

BlackDiamond X8 Series Switches, BlackDiamond 8800 Series Switches, SummitStack, and Summit Family Switches QoS Profile	802.1p Priority Value	DSCP
QP1	0	0
	1	8
	2	16
	3	24
	4	32
	5	40
	6	48
QP8	7	56

To replace DSCPs, you must enable DiffServ replacement using the following command:

```
enable diffserv replacement ports [<port_list> | all]
```



NOTE

The port in this command is the ingress port.

To disable this feature, use the following command:

```
disable diffserv replacement ports [<port_list> | all]
```

To view the current DiffServ replacement configuration, use the following command:

```
show diffserv replacement
```

To change the DSCP mapping, use the following commands:

```
configure diffserv replacement [{qosprofile} <qosprofile> | priority <priority>] code-
point <code_point>
unconfigure diffserv replacement
```

DiffServ Example

In this example, we use DiffServ to signal a class of service throughput and assign any traffic coming from network 10.1.2.x with a specific DSCP. This allows all other network switches to send and observe the DSCP instead of repeating the same QoS configuration on every network switch.

To configure the switch:

- 1 Using ACLs, assign a traffic grouping for traffic from network 10.1.2.x to QP3:

```
configure access-list qp3sub any
```

The following is a sample policy file example:

```
#filename: qp3sub.pol
entry QP3-subnet {
    if {
        source-address 10.1.2.0/24
    } then {
        Qosprofile qp3;
        replace-dscp;
    }
}
```

- 2 Configure the switch so that other switches can signal calls of service that this switch should observe by entering the following:

```
enable diffserv examination ports all
```



NOTE

The switch only observes the DSCPs if the traffic does not match the configured access list. Otherwise, the ACL QoS setting overrides the QoS DiffServ configuration.

Configuring Egress QoS Profile Rate Shaping

The following sections describe how to configure egress QoS Profile rate shaping:

- [Creating or Deleting an Egress QoS Profile on page 750](#)
- [Configuring an Egress QoS Profile on page 750](#)
- [Configuring WRED on an Egress QoS Profile on page 751](#)

Creating or Deleting an Egress QoS Profile

The default configuration for most platforms defines eight egress QoS profiles. On BlackDiamond 8800 switches, SummitStack, and Summit family switches, the default configuration defines two egress QoS profiles. On these platforms, use the following command to create an additional egress QoS profile:

```
create qosprofile [QP2 | QP3 | QP4 | QP5 | QP6 | QP7]
```

On BlackDiamond 8800 switches, SummitStack, and Summit family switches, use the following command to delete an egress QoS profile:

```
delete qosprofile [QP2 | QP3 | QP4 | QP5 | QP6 | QP7]
```

Configuring an Egress QoS Profile

Egress QoS profile rate shaping is disabled by default on all ports.

On all platforms, use the following commands to configure egress QoS profile rate shaping on one or more ports:

```
configure qosprofile egress <qosprofile> [{minbw <minbw_number>} {maxbw <maxbw_number>} | {peak_rate <peak_bps> [K | M]}] [ports [<port_list> | all]]
```

```
configure qosprofile <qosprofile> [{minbw <minbw_number>} {maxbw <maxbw_number>} | {{committed_rate <committed_bps> [K | M]} {peak_rate <peak_bps> [K | M]} | [ports [<port_list> | all]]]
```

```
configure {<qosprofile>} <qosprofile> [{maxbuffer <buffer_percentage>} {use-strict-priority}] | [maxbuffer <buffer_percentage> ports [<port-list> | all]]]
```



NOTE

You must use these commands on all platforms if you want to configure the buffer size or weight value. Otherwise, you can use the command in the following description.



NOTE

You cannot configure the priority for the QoS profile on BlackDiamond X8, 8800 series switches, SummitStack, or Summit family switches.

To remove the limit on egress bandwidth per QoS profile per port, re-issue this command using the default values.

To display the current configuration for the QoS profile, use the following command:

```
show qosprofile [ all | <port_list>]
```

Configuring WRED on an Egress QoS Profile

To configure or unconfigure WRED on an egress QoS profile, use the following commands:

```
configure {qosprofile} {egress} <qosprofile> [wred [{color [tcp [green | red] | non-
tcp [any|red]]] [{min-threshold <min_thresh>} {max-threshold <>} {max-drop-rate
<max_drop_rate>}}] | avg-weight <avg_weight>]] ports [<port-list> | all]
```

```
unconfigure qosprofile wred {ports [<port_list> | all]}
```

To display the WRED configuration settings, use the following command:

```
show wredprofile {ports [<port-list> | all]}
```

Configuring Egress Port Rate Limits

The following sections describe egress port rate limiting on different platforms:

- [Configuration on BlackDiamond X8 Series Switches, BlackDiamond 8800 Series Switches, SummitStack, and Summit Family Switches on page 751](#)
- [Refer to Chapter 14, “FDB,” for more information on limiting broadcast, multicast, or unknown MAC traffic ingressing the port. on page 752](#)

Configuration on BlackDiamond X8 Series Switches, BlackDiamond 8800 Series Switches, SummitStack, and Summit Family Switches

The default behavior is to have no limit on the egress traffic per port. To configure egress rate limiting, use the following command:

```
configure ports <port_list> rate-limit egress [no-limit | <cir-rate> [Kbps | Mbps |
Gbps] {max-burst-size <burst-size> [Kb | Mb}}]
```

To view the configured egress port rate-limiting behavior, use the following command:

```
show ports {mgmt | <port_list> | tag <tag>} information {detail}
```

You must use the `detail` parameter to display the egress port rate configuration and, if configured, the maximum burst size. Refer to [“Displaying Port Information”](#) for more information on the `show ports information` command.

You can also display this information using the following command:

```
show configuration vlan
```

The following is sample output from the `show configuration vlan` command for configured egress rate limiting:

```
# Module vlan configuration.
#
configure vlan Default tag 1
config port 3:1 rate-limit egress 128 Kbps max-burst-size 200 Kb
config port 3:2 rate-limit egress 128 Kbps
config port 3:10 rate-limit egress 73 Kbps max-burst-size 128 Kb
configure vlan Default add ports 3:1-48 untagged
```

**NOTE**

Refer to [Chapter 14, “FDB,”](#) for more information on limiting broadcast, multicast, or unknown MAC traffic ingressing the port.

Configuring Traffic Groups

The following sections describe how to configure traffic groups:

- [Configuring an ACL-Based Traffic Group on page 752](#)
- [Configuring a CoS 802.1p-Based Traffic Group on page 752](#)
- [Configuring a DiffServ-Based Traffic Group on page 753](#)
- [Configuring a Port-Based Traffic Group on page 754](#)
- [Configuring a VLAN-Based Traffic Group on page 755](#)

Configuring an ACL-Based Traffic Group

ACL-based traffic groups are introduced in [“ACL-Based Traffic Groups” on page 731](#). An ACL can implement multiple QoS features, so it is usually best to finalize the ACL after all other features have been configured.

To configure an ACL-based traffic group, do the following:

- 1 Create an ACL policy file and add rules to the file using the following guidelines:
 - a Use ACL match conditions to identify the traffic for the traffic group.
 - b Use ACL action modifiers to apply QoS features such as ingress meter or traffic queue selection, egress QoS profile or traffic queue selection, and 802.1p priority replacement to the traffic group.
- 2 Apply the ACL policy file to the ports where you want to define the traffic groups. You can apply the file to specific ports, all ports, or all ports in a VLAN.

ACLs are described in detail in [Chapter 18, “ACLs.”](#)

Configuring a CoS 802.1p-Based Traffic Group

As described in [“CoS 802.1p-Based Traffic Groups” on page 732](#), the default switch configuration defines CoS 802.1p-based traffic groups. The configuration options for these groups are described in the following sections:

- [Enabling and Disabling 802.1p Examination on page 752](#)
- [Changing the 802.1p Priority to QoS Profile Mapping on page 753](#)

**NOTE**

If you are using ACL-based traffic groups, use the `qosprofile` or `traffic-queue` action modifier to select a forwarding queue. Traffic that meets any ACL match conditions is not evaluated by other traffic groups.

Enabling and Disabling 802.1p Examination. CoS 802.1p examination is supported on all platforms and enabled by default. However, you can only disable and enable this feature on BlackDiamond 8800 series switches, SummitStack, and Summit family switches. To free ACL resources, disable this feature

whenever another QoS traffic grouping is configured. (See [Chapter 18, “ACLs,”](#) for information on available ACL resources.)

**NOTE**

If you disable this feature when no other QoS traffic grouping is in effect, 802.1p priority enforcement of 802.1q tagged packets continues. If only DiffServ traffic groups are enabled, then 802.1p priority enforcement for 802.1q tagged packets continues for non-IP packets using the default 802.1p map shown in [Table 90](#).

To disable the 802.1p examination feature on BlackDiamond X8 and 8800 switches, SummitStack, and Summit family switches, use the following command:

```
disable dot1p examination ports [<port_list> | all]
```

**NOTE**

802.1p examination cannot be disabled for 802.1p priority level 6 in a SummitStack. When 802.1p examination is disabled on a SummitStack, the precedence for the remaining examination becomes lower than that of all other traffic groupings.

To re-enable the 802.1p examination feature on BlackDiamond 8800 switches, SummitStack, and Summit family switches, use the following command:

```
enable dot1p examination ports [<port_list> | all]
```

To display whether the 802.1p examination feature is enabled or disabled, use the following command:

```
show ports {mgmt | <port_list> | tag <tag>} information {detail}
```

Changing the 802.1p Priority to QoS Profile Mapping. You can change the 802.1p priority to egress QoS profile mapping on BlackDiamond X8 and 8800 series switches, SummitStack, and Summit family switches.

To view the current 802.1p priority to QoS profile mapping on a switch, use the following command:

```
show dot1p
```

To change the mapping on BlackDiamond 8800 series switches, SummitStack, and Summit family switches, use the following command:

```
configure dot1p type <dot1p_priority> {qosprofile} <qosprofile>
```

Configuring a DiffServ-Based Traffic Group

As described in “[DiffServ-Based Traffic Groups](#)” on page 733, the default switch configuration defines DiffServ-based traffic groups. The configuration options for these groups are described in the following sections:

- [Enabling and Disabling Diffserv Examination on page 754](#)
- [Changing the DSCP to QOS Profile Mapping on page 754](#)

**NOTE**

If you are using ACL-based traffic groups, use the `qosprofile` or `traffic-queue` action modifier to select a forwarding queue. Traffic that meets any ACL match conditions is not evaluated by other traffic groups.

Enabling and Disabling Diffserv Examination. When a packet arrives at the switch on an ingress port and Diffserv examination is enabled, the switch uses the DSCP value to select the egress QoS profile that forwards the packet. The QoS profile configuration defines the forwarding characteristics for all traffic assigned to the QoS profile.

The DiffServ examination feature is disabled by default. To enable DiffServ examination, use the following command:

```
enable diffserv examination ports [<port_list> | all]
```

**NOTE**

When DiffServ examination is enabled on 1 Gigabit Ethernet ports for BlackDiamond 8800 series switches, SummitStack, and Summit family switches, 802.1p replacement is enabled and cannot be disabled. The ingress 802.1p value is replaced with the 802.1p value assigned to the egress QoS profile.

To disable DiffServ examination, use the following command:

```
disable diffserv examination ports [<port_list> | all]
```

Changing the DSCP to QoS Profile Mapping. You can change the egress QoS profile assignment for each of the 64 code points.

To view the current DSCP to QoS profile mapping, use the following command:

```
show diffserv examination
```

On BlackDiamond X8, 8800, SummitStack, and Summit family switches, use the following commands to change the DSCP to QoS profile mapping:

```
configure diffserv examination code-point <code_point> {qosprofile} <qosprofile>
```

```
unconfigure diffserv examination
```

After a QoS profile is assigned, the rest of the switches in the network prioritize the packet using the characteristics specified by the QoS profile.

Configuring a Port-Based Traffic Group

A port-based traffic group links a physical ingress port to an egress QoS profile for traffic forwarding. To configure a port-based traffic group, use the following command:

```
configure ports <port_list> {qosprofile} <qosprofile>
```

**NOTE**

If you are using ACL-based traffic groups, use the `qosprofile` or `traffic-queue` action modifier to select a forwarding queue. Traffic that meets any ACL match conditions is not evaluated by other traffic groups.

**NOTE**

On the BlackDiamond X8 switch, port-based traffic groups apply only to untagged packets. On the BlackDiamond 8800 series switches, SummitStack, and Summit family switches, port-based traffic groups apply to all packets.

Configuring a VLAN-Based Traffic Group

A VLAN-based traffic group links all ports in a VLAN to an egress QoS profile for traffic forwarding. All intra-VLAN switched traffic and all routed traffic sourced from the named VLAN uses the specified QoS profile. To configure a VLAN-based traffic group, use the following command:

```
configure vlan <vlan_name> {qosprofile} <qosprofile>
```



NOTE

If you are using ACL-based traffic groups, use the `qosprofile` or `traffic-queue` action modifier to select a forwarding queue. Traffic that meets any ACL match conditions is not evaluated by other traffic groups.



NOTE

On the BlackDiamond X8 VLAN-based traffic groups apply only to untagged packets. On the BlackDiamond 8800 series switches, SummitStack, and Summit family switches, VLAN-based traffic groups apply to all packets.

Creating and Managing Meters

You can configure meters to define bandwidth requirements on BlackDiamond 8800, SummitStack, and Summit family switches. The following sections describe how to use meters:

- [Creating Meters on page 755](#)
- [Configuring a Meter on page 755](#)
- [Applying a Meter to Ingress or Egress Traffic on page 755](#)
- [Deleting a Meter on page 756](#)

Creating Meters

To create a meter, use the following command:

```
create meter <meter-name>
```

To display the meters already configured on the switch, use the `show meter <meter_name>` command.

Configuring a Meter

After you create a meter, you configure the meter using the command for the platform you are using.

To configure a QoS meter on all platforms, use the following command:

```
configure meter <metername> {committed-rate <cir> [Gbps | Mbps | Kbps]} {max-burst-size <burst-size> [Kb | Mb]} {out-actions [drop | set-drop-precedence {dscp [none | <dscp-value>]}]}
```

Applying a Meter to Ingress or Egress Traffic

You can apply a meter to ingress traffic using an ACL on BlackDiamond 8800 series switches, SummitStack, and Summit family switches. You can apply a meter to egress traffic using an ACL on BlackDiamond c-, xl-, and xm-series modules, and Summit X650 and X670 switches.

Use rules within the ACL to identify the ingress traffic to which you want to apply the meter. Apply the meter by specifying the meter name with the `meter <metername>` action modifier. For information on completing the ACL configuration, see “[Configuring an ACL-Based Traffic Group](#)” on page 752.

Deleting a Meter

To delete a meter, use the following command:

```
delete meter <metername>
```



NOTE

The associated meters are not deleted when you delete any type of traffic queue. Those meters remain and can be associated with other traffic queues. To display the configured meters, use the `show meter <meter_name>` command.

Adjusting the Byte Count Used to Calculate Traffic Rates

You can configure a per-packet byte adjustment that the system uses to calculate the ingress traffic rate, traffic utilization, and traffic statistics. You configure either the number of bytes you want subtracted from each packet ingressing the specified ports or the number of bytes you want added to the packet ingressing the specified ports.

By default, all bytes are counted for the ingressing traffic rate. After you issue this command, the default number of bytes removed is 0; you can add or subtract from 1 to 4 bytes from each ingressing packet on the specified ports for calculating the ingressing traffic rate.

To display the number of bytes added to or subtracted from the packet to calculate the ingressing traffic rate, traffic utilization, and traffic statistics, use the following command:

```
show ports <port_list> information detail
```



NOTE

You must use the `detail` keyword to display this information.

To unconfigure this setting, re-issue the command and enter the value 0.

Controlling Flooding, Multicast, and Broadcast Traffic on Ingress Ports

On BlackDiamond 8800 series switches, SummitStack, and Summit family switches, you can use the following command to control ingress flooding of broadcast and multicast traffic and traffic for unknown destination MAC addresses:

```
configure ports <port_list> rate-limit flood [broadcast | multicast | unknown-destmac]  
[no-limit | <pps>]
```

Displaying QoS Configuration and Performance

The following sections describe ways to display QoS configuration and performance information:

- [Displaying Traffic Group Configuration Data on page 757](#)
- [Displaying Performance Statistics on page 757](#)

Displaying Traffic Group Configuration Data

The following sections describe how to display traffic group configuration data:

- [Displaying 802.1p Priority to QoS Profile Mappings on page 757](#)
- [Displaying DiffServe DSCP to QoS Profile Mappings on page 757](#)
- [Displaying Port and VLAN QoS Settings on page 757](#)

Displaying 802.1p Priority to QoS Profile Mappings

To display the 802.1p priority to egress QoS profile mappings, use the following command:

```
show dot1p
```

Displaying DiffServe DSCP to QoS Profile Mappings

To display the DiffServ DSCP to egress QoS profile mappings, use the following commands:

```
show diffserv examination
```

Displaying Port and VLAN QoS Settings

You can display QoS settings assigned to ports or VLANs by entering the following command:

```
show ports {mgmt | <port_list> | tag <tag>} information {detail}
```

**NOTE**

To ensure that you display the QoS information, you must use the `detail` keyword.

This command can display the following:

- On the BlackDiamond 8800 series, SummitStack, and Summit family switches, this command displays which QoS profile, if any, is configured.

Displaying Performance Statistics

The following sections describe how to display QoS performance statistics:

- [Displaying QoS Profile Traffic Statistics on page 758](#)
- [Displaying Congestion Statistics on page 759](#)

Displaying QoS Profile Traffic Statistics

After you have created QoS policies that manage the traffic through the switch, you can use the QoS monitor to determine whether the application performance meets your expectations. The QoS monitor allows you to display the traffic packet counts in a real-time or a snapshot display for the specified ports.

To view QoS profile traffic statistics on BlackDiamond X8 series switches, BlackDiamond 8000 series modules, SummitStack, and the Summit X250e, X440, X450a, X450e, X460, X480, X650, and X670 series switches, use the following command:

```
show ports <port_list> qosmonitor {congestion} {no-refresh}
```



NOTE

On BlackDiamond 8500 and 8800 a-, c-, and e-series modules, only one port per slot or module can be monitored at any one time. This restriction does not apply to BlackDiamond 8900 series modules.



NOTE

On BlackDiamond X8 series switches, BlackDiamond 8900 xm-series modules and Summit X670 series switches, QP1-4 support one unicast and one multicast queue for each QoS profile. The QoS monitor counters for QP1-4 tally the unicast and multicast traffic for these QoS profiles. QoS monitor counters for QP5-8 tally only the unicast traffic for these QoS profiles.

To view or clear the WRED statistics on BlackDiamond X8 series switches, BlackDiamond 8900 c-, xl-, and xm-series modules, E4G-200 and E4G-400 cell site routers, and Summit X460, X480, X650, and X670 switches, use the following commands:

```
show ports <port_list> wred {no-refresh}
```

```
clear counters wred
```

To view QoS profile traffic statistics on BlackDiamond 8800, use the following command:

```
show ports <port_list> qosmonitor {ingress | egress} {bytes | packets} {no-refresh}
```

Displaying Congestion Statistics

To display a count of the packets dropped due to congestion on a port, enter the following command:

```
show ports <port_list> congestion {no-refresh}
```

To display a count of the packets dropped due to congestion in the QoS profiles for a port, enter the following command:

```
show ports <port_list> qosmonitor {congestion} {no-refresh}
```



NOTE

On BlackDiamond 8500 and 8800 c-, and e-series modules, only one port per slot or module can be monitored at any one time. This restriction does not apply to BlackDiamond 8900 series modules.



NOTE

On BlackDiamond 8900 xm-series modules and Summit X670 series switches, QP1-4 support one unicast and one multicast queue for each QoS profile. The congestion counters for QP1-4 tally the unicast and multicast traffic for these QoS profiles. Congestion counters for QP5-8 tally only the unicast traffic for these QoS profiles.

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CHAPTER

Network Login

This chapter includes the following sections:

- [Overview on page 761](#)
- [Configuring Network Login on page 769](#)
- [Authenticating Users on page 771](#)
- [Local Database Authentication on page 772](#)
- [802.1x Authentication on page 776](#)
- [Web-Based Authentication on page 786](#)
- [MAC-Based Authentication on page 794](#)
- [Additional Network Login Configuration Details on page 798](#)

Overview

Network login controls the admission of user packets into a network by allowing MAC addresses from users that are properly authenticated. Network login is controlled on a per port basis. When network login is enabled on a port, that port does not forward any packets until authentication takes place.

Network login is capable of three types of authentication: web-based, MAC-based, and 802.1x. In addition, network login has two different modes of operation: Campus mode and ISP mode. The authentication types and modes of operation can be used in any combination.

When web-based network login is enabled on a switch port, that port is placed into a non-forwarding state until authentication takes place. To authenticate, a user must open a web browser and provide the appropriate credentials. These credentials are either approved, in which case the port is placed in forwarding mode, or not approved, in which case the port remains blocked. You can initiate user logout by submitting a logout request or closing the logout window.

The following capabilities are included with network login:

- Web-based login using HTTP available on each port
- Web-based login using HTTPS—if you install the SSH software module that includes SSL—available on each port
- Multiple supplicants for web-based, MAC-based, and 802.1x authentication on each port

The remainder of this section describes the following topics:

- [Web-Based, MAC-Based, and 802.1x Authentication on page 765](#)

- [Multiple Supplicant Support on page 767](#)
- [Campus and ISP Modes on page 767](#)
- [Network Login and Hitless Failover on page 768](#)

ExtremeXOS NetLogin provides the AAA (Authentication, Authorization, and Accounting) functionality, which, is an important block of the network infrastructure and security, and provides a model or framework to determine who is requesting network access, network resources that can be accessed by the requesting party, and when the resources are used. NetLogin supports all popular methods of authentication - MAC-based, Web-based, and IEEE 802.1X. NetLogin can help network administrators to control access into the network, and also provides flexibility to configure specific backend resources to which user access is allowed. Together with IP Security, administrators can enhance security in the network by controlling access to upstream network and resources by the hosts or clients. IP Security is a collection of a powerful set of features that allow network administrators to design security in combination with standard authentication and authorization techniques. IP Security features as ExtremeXOS 15.2 include:

- DHCP Snooping and concept of trusted DHCP Servers
- Source IP Lockdown
- ARP Learning and Validation
- Gratuitous ARP Protection

When NetLogin and IP Security features are enabled on a port - While NetLogin performs the first or the basic function of authenticating and authorizing the user, further course of action is determined by

IP Security in case a violation is detected. The violation action will then determine further access to the network.

Table 92:

Scenario	Notes	Expected Behavior
<p>Netlogin + DHCP Snooping and trusted DHCP Servers/Ports.</p> <p>Violation: DHCP Server Packets seen on netlogin enabled ports (i.e. a host is masquerading post authentication).</p>	<p>We recommend that you enable NetLogin on the client facing ports. Enabling DHCP Snooping on all ports, including client/host facing ports and ports connected to the upstream network automation and provisioning infrastructure, ensures that all DHCP messages are processed by the switch and a DHCP binding database is maintained.</p> <p>For the combination of NetLogin and DHCP Security to work correctly, we recommend that you configure at least one uplink (or server facing port) as a trusted port. This ensures that all other ports (normally client facing ports) automatically become un-trusted, and can be monitored for any violations that might occur. You can configure more than one uplink port as "trusted" as this allows flexibility in network design.</p> <p><u>In addition to controlling which DHCP Servers can communicate with the downstream clients, the trusted DHCP Server configuration can be used.</u></p>	<p>Action: None</p> <p>NetLogin authenticates the client, and IP Security flags a violation. No action is taken because of configuration.</p> <p>Action: Drop-packet</p> <p>The packet is dropped, and an EMS event is logged.</p> <p>Action: block-mac</p> <p>NetLogin initially authenticates the client, and subsequently when the violation occurs, IP Security reports violation, which causes the MAC address to be blocked either permanently or for a configured duration on the switch. The FDB will be flushed after FDB entry ages out and the netlogin entry is unauthenticated and removed from the switch.</p> <p>Action: block-port</p> <p>NetLogin initially authenticates the client, and subsequently when the violation occurs, IP Security reports the violation, which causes the port to be administratively disabled. As a result, all authenticated clients on the ports are immediately unauthenticated and removed from the switch. This can occur either for a certain configured duration or permanently.</p> <p>We do not recommend that you use this configuration if there are multiple supplicants on the port (for example, conference rooms, groups of users, etc. accessing the network through an intermediate port extender, or hub).</p> <p>In addition, for network troubleshooting and debugging purposes, an SNMP trap can be sent to a central network manager such as Ridgeline.</p>

Table 92:

Scenario	Notes	Expected Behavior
NetLogin + ARP Validation	<p>ARP Validation helps check different fields in the ARP packet. Source MAC, Destination MAC, and Source IP addresses can be checked for validity.</p> <p>For a complete reference to the different checks performed, please refer to the ARP Validation Options table in the ExtremeXOS Concepts Guide (Chapter Security: IP Security: ARP Validation).</p> <p>All checks are performed post authentication.</p>	<p>Violation actions are same as the options presented in the DHCP Snooping and Validation Cases.</p> <p>Same expected behavior and functionality as in the case of "NetLogin + DHCP Snooping and Trusted Ports/Servers".</p>
NetLogin + Gratuitous ARP Protection	<p>Gratuitous ARP is a method by which a client/host can resolve its own IP address, and is useful in scenarios where duplicate addresses need to be detected, or a host can announce that it has either used an IP address on a different NIC card, or even if a client has moved from one location to another.</p> <p>While ExtremeXOS supports Gratuitous ARP, protection can also be enabled to mitigate any risks or threats that can arise because of any m-i-m attacks. The switch will automatically send ARP packets to not only protect its own IP address but to also safeguard addresses of any NetLogin authenticated clients on the switch. For this, it is recommended that both DHCP Secured ARP and Gratuitous ARP protection be enabled on the switch.</p> <p>It is not mandatory that DHCP Snooping be enabled for this feature, but becomes a prerequisite if DHCP Secured ARP is also configured.</p>	<p>ARP Packets are sent out when a violation is detected.</p> <p>For all other violations detected by DHCP Snooping and Trust, the corresponding violation actions are determined by configuration, and expected behavior is the same as the case of "NetLogin + DHCP Snooping and Trusted Ports/Server".</p>

Web-Based, MAC-Based, and 802.1x Authentication

Authentication is handled as a web-based process, MAC-based process, or as described in the IEEE 802.1x specification. Web-based network login does not require any specific client software and can work with any HTTP-compliant web browser. By contrast, 802.1x authentication may require additional software installed on the client workstation, making it less suitable for a user walk-up situation, such as a cyber-café or coffee shop. A workstation running Windows 2000 Service Pack 4 or Windows XP supports 802.1x natively and does not require additional authentication software. Extreme Networks supports a smooth transition from web-based to 802.1x authentication.

MAC-based authentication is used for supplicants that do not support a network login mode, or supplicants that are not aware of the existence of such security measures, for example an IP phone.

If a MAC address is detected on a MAC-based enabled network login port, an authentication request is sent once to the AAA application. AAA tries to authenticate the MAC address against the configured Remote Authentication Dial In User Server (RADIUS) server and its configured parameters (timeout, retries, and so on) or the configured local database.

The credentials used for this are the supplicant's MAC address in ASCII representation and a locally configured password on the switch. If no password is configured the MAC address is also used as the password. You can also group MAC addresses together using a mask.

Dynamic Host Control Protocol (DHCP) is required for web-based network login because the underlying protocol used to carry authentication request-response is HTTP. The client requires an IP address to send and receive HTTP packets. Before the client is authenticated, however, the only connection that exists is to the authenticator. As a result, the authenticator must be furnished with a temporary DHCP server to distribute the IP address.

The switch responds to DHCP requests for unauthenticated clients when DHCP parameters such as `dhcp-address-range` and `dhcp-options` are configured on the network login VLAN. The switch can also answer DHCP requests following authentication if DHCP is enabled on the specified VLAN. If network login clients are required to obtain DHCP leases from an external DHCP server elsewhere on the network, DHCP should not be enabled on the VLAN.

The DHCP allocation for network login has a short time duration of 10 seconds and is intended to perform web-based network login only. As soon as the client is authenticated, it is deprived of this address. The client must obtain an operational address from another DHCP server in the network. DHCP is not required for 802.1x, because 802.1x uses only Layer 2 frames (EAPOL) or MAC-based network login.

URL redirection (applicable to web-based mode only) is a mechanism to redirect any HTTP request to the base URL of the authenticator when the port is in unauthenticated mode. In other words, when the user tries to log in to the network using the browser, the user is first redirected to the network login page. Only after a successful login is the user connected to the network. URL redirection requires that the switch is configured with a DNS client.

Web-based, MAC-based, and 802.1x authentication each have advantages and disadvantages, as summarized next.

Advantages of Web-Based Authentication:

- Works with any operating system that is capable of obtaining an IP address using DHCP. There is no need for special client side software; only a web browser is needed.

Disadvantages of Web-Based Authentication:

- The login process involves manipulation of IP addresses and must be done outside the scope of a normal computer login process. It is not tied to a Windows login. The client must bring up a login page and initiate a login.
- Supplicants cannot be re-authenticated transparently. They cannot be re-authenticated from the authenticator side.
- This method is not as effective in maintaining privacy protection.

Advantages of MAC-Based Authentication:

- Works with any operating system or network enabled device.
- Works silently. The user, client, or device does not know that it gets authenticated.
- Ease of management. A set of devices can easily be grouped by the vendor part of the MAC address.

Disadvantages of MAC-Based Authentication:

- There is no re-authentication mechanism. The FDB aging timer determines the logout.
- Security is based on the MAC address of the client, so the network is more vulnerable to spoofing attacks.

Advantages of 802.1x Authentication:

- In cases where the 802.1x is natively supported, login and authentication happens transparently.
- Authentication happens at Layer 2. It does not involve getting a temporary IP address and subsequent release of the address to obtain a permanent IP address.
- Allows for periodic, transparent re-authentication of supplicants.

Disadvantages of 802.1x Authentication:

- 802.1x native support is available only on newer operating systems, such as Windows XP.
- 802.1x requires an EAP-capable RADIUS Server. Most current RADIUS servers support EAP, so this is not a major disadvantage.
- Transport Layer Security (TLS) and Tunneled TLS (TTLS) authentication methods involve Public Key Infrastructure (PKI), which adds to the administrative requirements.

Multiple Supplicant Support

An important enhancement over the IEEE 802.1x standard is that ExtremeXOS supports multiple clients (supplicants) to be individually authenticated on the same port. This feature makes it possible for two or more client stations to be connected to the same port, with some being authenticated while others are not. A port's authentication state is the logical “OR” of the individual MAC's authentication states. In other words, a port is authenticated if any of its connected clients is authenticated. Multiple clients can be connected to a single port of authentication server through a hub or Layer 2 switch.

Multiple supplicants are supported in ISP mode for web-based, 802.1x, and MAC-based authentication. In addition, multiple supplicants are supported in Campus mode if you configure and enable network login MAC-based VLANs. For more information, see [“Configuring Network Login MAC-Based VLANs” on page 798](#).

The choice of web-based versus 802.1x authentication is again on a per-MAC basis. Among multiple clients on the same port, it is possible that some clients use web-based mode to authenticate, and some others use 802.1x, but the restriction is that they must be in the same untagged VLAN. This restriction is not applicable if you configure network login MAC-based VLANs. For more information, see [“Configuring Network Login MAC-Based VLANs” on page 798](#).

**NOTE**

With multiple supplicant support, after the first MAC is authenticated, the port is transitioned to the authenticated state and other unauthenticated MACs can listen to all data destined for the first MAC. Be aware of this as unauthenticated MACs can listen to all broadcast and multicast traffic directed to a network login-authenticated port.

Campus and ISP Modes

Network login supports two modes of operation, Campus and ISP. Campus mode is intended for mobile users who tend to move from one port to another and connect at various locations in the network. ISP mode is meant for users who connect through the same port and VLAN each time (the switch functions as an ISP).

In Campus mode, the clients are placed into a permanent VLAN following authentication with access to network resources. For wired ports, the port is moved from the temporary to the permanent VLAN.

In ISP mode, the port and VLAN remain constant. Before the supplicant is authenticated, the port is in an unauthenticated state. After authentication, the port forwards packets.

You do not explicitly configure the mode of operation; rather, the presence of any Extreme Networks Vendor Specific Attribute (VSA) that has a VLAN name or VLAN ID (any VLAN attribute) in the RADIUS server determines the mode of operation. If a VLAN attribute is present, it is assumed to be Campus mode. If a VLAN attribute is not present, it is assumed to be ISP mode.

**NOTE**

When a client is authenticated in multiple VLANs using campus mode: 1) If any of the authenticated VLANs are deleted manually from a port or globally, the client is unauthenticated from all VLANs; and 2) If traffic is not seen on a particular VLAN then the FDB entry ages out and is deleted; the client itself remains authenticated and the FDB entry is reinstalled either when traffic is detected on that VLAN or when the client reauthenticates. For additional information on Campus and ISP mode operation on ports that support network login and STP, see [“Exclusions and Limitations” on page 771](#).

Network Login and Hitless Failover

**NOTE**

This section applies to modular switches.

When you install two management modules (nodes) in a BlackDiamond chassis or when redundancy is available in a SummitStack, one node assumes the role of primary and the another node assumes the role of backup node. The primary node executes the switch’s management functions, and the backup node acts in a standby role. Hitless failover transfers switch management control from the primary node to the backup node.

**NOTE**

Not all platforms support hitless failover in the same software release. To verify if the software version you are running supports hitless failover, see [Table 15 in Chapter 2, “Managing the Switch.”](#) For more information about protocol, platform, and MSM support for hitless failover, see [“Understanding Hitless Failover Support—Modular Switches and SummitStack Only” in Chapter 2, “Managing the Switch.”](#)

Network login supports hitless failover by relaying current client authentication information from the master node to the backup node. For example, if a client moves to the authenticated state, or moves from an authenticated state to an unauthenticated state, the primary node conveys this information to the backup node. If failover occurs, your authenticated client continues to operate as before the failover.

**NOTE**

If you use 802.1x network login, authenticated clients remain authenticated during failover; however, shortly after failover, all authenticated clients automatically re-authenticate themselves. Re-authentication occurs without user intervention.

If failover occurs during the authentication or re-authentication of a client, the client must repeat the authentication process.

**NOTE**

Before initiating failover, review the section “[Synchronizing Nodes—Modular Switches and SummitStack Only](#)” on page 1500 to confirm that your switch (or SummitStack) and both (or all) nodes are running software that supports the `synchronize` command.

To initiate hitless failover on a network that uses network login:

- 1 Confirm that the nodes are synchronized and have identical software and switch configurations using the `show switch {detail}` command. The output displays the status of the primary and backup nodes, with the primary node showing `MASTER` and the backup node showing `BACKUP (InSync)`.
 - If the primary and backup nodes, are not synchronized and both nodes are running a version of ExtremeXOS that supports synchronization, proceed to step 2.
 - If the primary and backup nodes, are synchronized, proceed to step 3.
- 2 If the primary and backup nodes, are not synchronized, use the `synchronize` command to replicate all saved images and configurations from the primary to the backup.
After you confirm that the nodes are synchronized, proceed to step 3.
- 3 If the nodes are synchronized, use the `run msm-failover` command to initiate failover.

For more detailed information about verifying the status of the nodes and system redundancy, see “[Understanding System Redundancy—Modular Switches and SummitStack Only](#)” on page 81. For more information about hitless failover, see “[Understanding Hitless Failover Support—Modular Switches and SummitStack Only](#)” on page 85.

Configuring Network Login

This section provides a general overview of the commands used for:

- [Enabling or Disabling Network Login on the Switch on page 769](#)
- [Enabling or Disabling Network Login on a Specific Port on page 770](#)
- [Configuring the Move Fail Action on page 770](#)
- [Displaying Network Login Settings on page 770](#)
- [Exclusions and Limitations on page 771](#)

This section also describes information about the [Exclusions and Limitations](#) of network login.

For more detailed information about a specific mode of network login, including configuration examples, refer to the following sections:

- [802.1x Authentication on page 776](#)
- [Web-Based Authentication on page 786](#)
- [MAC-Based Authentication on page 794](#)

Enabling or Disabling Network Login on the Switch

To enable or disable network login, use one of the following commands and specify the authentication method:

```
enable netlogin [{dot1x} {mac} {web-based}]
disable netlogin [{dot1x} {mac} {web-based}]
```

By default, network login is disabled.

Enabling or Disabling Network Login on a Specific Port

To enable network login on a port, use the following command to specify the ports and the authentication method:

```
enable netlogin ports <ports> [{dot1x} {mac} {web-based}]
```

By default, all methods of network login are disabled on all ports.



NOTE

When network login and STP are enabled on the same port, network login operates only when the STP port is in the forwarding state.

Network login must be disabled on a port before you can delete a VLAN that contains that port. To disable network login, use the following command:

```
disable netlogin ports <ports> [{dot1x} {mac} {web-based}]
```

Configuring the Move Fail Action

If network login fails to perform Campus mode login, you can configure the switch to authenticate the client in the original VLAN or deny authentication even if the user name and password are correct. For example, this may occur if a destination VLAN does not exist. To configure the behavior of network login if a VLAN move fails, use the following command:

```
configure netlogin move-fail-action [authenticate | deny]
```

By default, the setting is `deny`.

The following describes the parameters of this command if two clients want to move to a different untagged VLAN on the same port:

- `authenticate`—Network login authenticates the first client that requests a move and moves that client to the requested VLAN. Network login authenticates the second client but does not move that client to the requested VLAN. The second client moves to the first client's authenticated VLAN.
- `deny`—Network login authenticates the first client that requests a move and moves that client. Network login does not authenticate the second client.

The `dot1x` client is not informed of the VLAN move-fail because it always receives EAP-Success or EAP-Fail directly based on the authentication result, not based on both authentication and the VLAN move result.

Displaying Network Login Settings

To display the network login settings and parameters, use the following command:

```
show netlogin {port <portlist> vlan <vlan_name>} {dot1x {detail}} {mac} {web-based}
```

Exclusions and Limitations

The following are limitations and exclusions for network login:

- All unauthenticated MACs will be seeing broadcasts and multicasts sent to the port if even a single MAC is authenticated on that port.
- Network login must be disabled on a port before that port can be deleted from a VLAN.
- In Campus mode on all switches with untagged VLANs and the network login ports' mode configured as port-based-VLAN, after the port moves to the destination VLAN, the original VLAN for that port is not displayed.
- A network login VLAN port should not be a part of following protocols:
 - Ethernet Automatic Protection Switching (EAPS)
 - Extreme Standby Router Protocol (ESRP)
 - Link Aggregation
- Network login and ELRP are not supported on the same port.
- Network login and IP security are not supported on the same port.
- Network login and STP operate on the same port as follows:
 - At least one VLAN on the intended port should be configured both for network login and STP.
 - Network login and STP operate together only in network login ISP mode.
 - When STP blocks a port, network login does not process authentication requests and BPDUs are the only traffic in and out of the port. All user data forwarding stops.
 - When STP places a port in forwarding state, network login operates and BPDUs and user data flow in and out of the port. The forwarding state is the only STP state that allows network login and user data forwarding.
 - If a network login client is authenticated in ISP mode and STP blocks one of the authenticated VLANs on a given port, the client is unauthenticated only from the port or VLAN which is blocked.
 - All clients that are going through authentication and are learned on a blocked port or VLAN are cleared.

Authenticating Users

Network login uses two types of databases to authenticate users trying to access the network:

- RADIUS servers
- Local database

All three network login protocols, web-based, MAC-based, and 802.1x, support RADIUS authentication. Only web-based and MAC-based network login support local database authentication.



NOTE

If you are configuring both a network login RADIUS server and a Local-User database, you can control which database is used first for authentication in case authentication fails. For additional details, see the command reference pages [configure netlogin authentication database-order](#) and [unconfigure netlogin authentication database-order](#) in the ExtremeXOS Command Reference Guide.

The network login authenticated entry is cleared when there is an FDB timeout. This applies to web-based, MAC-Based, and 802.1x authentication.

Local Database Authentication

You can configure the switch to use its local database for web-based and MAC-based network login authentication. 802.1x network login does not support local database authentication. Local authentication essentially mimics the functionality of the remote RADIUS server locally. This method of authentication is useful in the following situations:

- If both the primary and secondary (if configured) RADIUS servers timeout or are unable to respond to authentication requests
- If no RADIUS servers are configured
- If the RADIUS server used for network login authentication is disabled

If any of the above conditions are met, the switch checks for a local user account and attempts to authenticate against that local account.

For local authentication to occur, you must configure the switch's local database with a user name and password for network login. Extreme Networks recommends a maximum of 64 local accounts. If you need more than 64 local accounts, Extreme Networks recommends using RADIUS for authentication. You can also specify the destination VLAN to enter upon a successful authentication.

You can also use local database authentication in conjunction with network login MAC-based VLANs. For more detailed information about network login MAC-based VLANs, see [“Configuring Network Login MAC-Based VLANs” on page 798](#).

The following sections describe how to configure your switch for local database authentication:

- [Creating a Local Network Login Account—User Name and Password Only on page 772](#)
- [Specifying a Destination VLAN on page 773](#)
- [Modifying an Existing Local Network Login Account on page 774](#)
- [Displaying Local Network Login Accounts on page 775](#)
- [Deleting a Local Network Login Account on page 776](#)

Creating a Local Network Login Account—User Name and Password Only

Extreme Networks recommends creating a maximum of 64 local accounts. If you need more than 64 local accounts, Extreme Networks recommends using RADIUS for authentication. For information about RADIUS authentication, see [“Configuring the RADIUS Client” on page 872](#).

To create a local network login user name and password, use the following command and specify the `<user-name>` parameter:

```
create netlogin local-user <user-name> {encrypted} {<password>} {vlan-vsa [{tagged | untagged} [<vlan_name>] | <vlan_tag>]} {security-profile <security_profile>}
```

User names are not case-sensitive. Passwords are case-sensitive. User names must have a minimum of 1 character and a maximum of 32 characters. Passwords must have a minimum of 0 characters and a

maximum of 32 characters. If you use RADIUS for authentication, Extreme Networks recommends that you use the same user name and password for both local authentication and RADIUS authentication.

If you attempt to create a user name with more than 32 characters, the switch displays the following messages:

```
%% Invalid name detected at '^' marker.
%% Name cannot exceed 32 characters.
```

If you attempt to create a password with more than 32 characters, the switch displays the following message after you re-enter the password:

```
Password cannot exceed 32 characters
```

The encrypted option is used by the switch to encrypt the password. Do not use this option through the command line interface (CLI). After you enter a local network login user name, press [Return]. The switch prompts you twice to enter the password.

The following example:

- Creates a new local network login user name
- Creates a password associated with the local network login user name

```
create netlogin local-user megtest
password: <Enter the password. The switch does not display the password.>
Reenter password: <Re-enter the password. The switch does not display the password.>
```

For information about specifying the destination VLAN, see the next section “[Specifying a Destination VLAN.](#)”



NOTE

If you do not specify a password or the keyword `encrypted`, you are prompted for one.

Specifying a Destination VLAN

If you configure a local network login account with a destination VLAN, upon successful authentication, the client transitions to the permanent, destination VLAN. You can specify the destination VLAN when you initially create the local network login account or at a later time.

Adding VLANs when Creating a Local Network Login Account

To specify the destination VLAN when creating the local network login account, use the following command and specify the `vlan-vs-a` option with the associated parameters:

```
create netlogin local-user <user-name> {encrypted} {<password>} {vlan-vs-a [[tagged |
untagged] [<vlan_name>] | <vlan_tag>]]} {security-profile <security_profile>}
```

Where the following is true:

- `tagged`—Specifies that the client be added as tagged
- `untagged`—Specifies that the client be added as untagged
- `vlan_name`—Specifies the name of the destination VLAN
- `vlan_tag`—Specifies the VLAN ID, tag, of the destination VLAN

The following example:

- Creates a new local network login user name
- Creates a password associated with the local network login user name
- Adds the VLAN test1 as the destination VLAN

The following is a sample display from this command:

```
create netlogin local-user megtest vlan-vsa "test1"
password: <Enter the password. The switch does not display the password.>
Reenter password: <Re-enter the password. The switch does not display the password.>
```

Adding VLANs at a Later Time

To specify the destination VLAN after you created the local network login account, use the following command:

```
configure netlogin local-user <user-name> {vlan-vsa [{tagged | untagged} [<vlan_name>
| <vlan_tag>]] | none}}
```

Where the following is true:

- tagged—Specifies that the client be added as tagged
- untagged—Specifies that the client be added as untagged
- vlan_name—Specifies the name of the destination VLAN
- vlan_tag—Specifies the VLAN ID, tag, of the destination VLAN
- none—Specifies that the VSA 211 wildcard (*) is applied, only if you do not specify tagged or untagged

The following example:

- Modifies a previously created local network login account
- Specifies that clients are added as tagged to the VLAN
- Adds the VLAN blue as the destination VLAN

```
configure netlogin local-user megtest vlan-vsa tagged "blue"
```

Modifying an Existing Local Network Login Account

After you create a local network login user name and password, you can update the following attributes of that account:

- Password of the local network login account
- Destination VLAN attributes including: adding clients tagged or untagged, the name of the VLAN, and the VLAN ID

If you try modifying a local network login account that is not present on the switch, or you incorrectly enter the name of the account, output similar to the following appears:

```
* Switch # configure netlogin local-user purplenet
                                     ^
%% Invalid input detected at '^' marker.
```

To confirm the names of the local network login accounts on your switch, use the following command:

```
show netlogin local-users
```

Updating the Local Network Login Password

To update the password of an existing local network login account, use the following command:

```
configure netlogin local-user <user_name>
```

Where `user_name` specifies the name of the existing local network login account. After you enter the local network login user name, press [Return]. The switch prompts you to enter a password. At the prompt enter the new password and press [Return]. The switch then prompts you to reenter the password.

Passwords are case-sensitive. Passwords must have a minimum of 0 characters and a maximum of 32 characters. If you attempt to create a password with more than 32 characters, the switch displays the following message after you re-enter the password:

```
Password cannot exceed 32 characters
```

The following example modifies the password for the existing local network login account `megtest`. The following is a sample display from this command:

```
configure netlogin local-user megtest
password: <Enter the new password. The switch does not display the password.>
Reenter password: <Re-enter the new password. The switch does not display the
password.>
```

After you complete these steps, the password has been updated.

Updating VLAN Attributes

You can add a destination VLAN, change the destination VLAN, or remove the destination VLAN from an existing local network login account. To make any of these VLAN updates, use the following command:

```
configure netlogin local-user <user-name> {vlan-vsa [{tagged | untagged} [<vlan_name>
| <vlan_tag>]] | none}
```

With the following:

- `user_name`—Specifies the name of the existing local network login account
- `tagged`—Specifies that the client be added as tagged
- `untagged`—Specifies that the client be added as untagged
- `vlan_name`—Specifies the name of the destination VLAN
- `vlan_name_tag`—Specifies the VLAN ID, tag, of the destination VLAN
- `none`—Specifies that the VSA 211 wildcard (*) is applied, only if you do not specify tagged or untagged

Displaying Local Network Login Accounts

To display a list of local network login accounts on the switch, including VLAN information, use the following command:

```
show netlogin local-users
```

Deleting a Local Network Login Account

To delete a local network login user name and password, use the following command:

```
delete netlogin local-user <user-name>
```

802.1x Authentication

802.1x authentication methods govern interactions between the supplicant (client) and the authentication server. The most commonly used methods are Transport Layer Security (TLS); Tunneled TLS (TTLS), which is a Funk/Certicom standards proposal; and PEAP.

TLS is the most secure of the currently available protocols, although TTLS is advertised to be as strong as TLS. Both TLS and TTLS are certificate-based and require a Public Key Infrastructure (PKI) that can issue, renew, and revoke certificates. TTLS is easier to deploy, as it requires only server certificates, by contrast with TLS, which requires client and server certificates. With TTLS, the client can use the MD5 mode of user name/password authentication.

If you plan to use 802.1x authentication, refer to the documentation for your particular RADIUS server and 802.1x client on how to set up a PKI configuration.

This section describes the following topics:

- [Interoperability Requirements on page 776](#)
- [Enabling and Disabling 802.1x Network Login on page 777](#)
- [802.1x Network Login Configuration Example on page 777](#)
- [Configuring Guest VLANs on page 778](#)
- [Post-authentication VLAN Movement on page 781](#)
- [802.1x Authentication and Network Access Protection on page 782](#)

Interoperability Requirements

For network login to operate, the user (supplicant) software and the authentication server must support common authentication methods. Not all combinations provide the appropriate functionality.

Supplicant Side

The supported 802.1x clients (supplicants) are Windows 2000 SP4 native client, Windows XP native clients, and Meetinghouse AEGIS.

A Windows XP 802.1x supplicant can be authenticated as a computer or as a user. Computer authentication requires a certificate installed in the computer certificate store, and user authentication requires a certificate installed in the individual user's certificate store.

By default, the Windows XP machine performs computer authentication as soon as the computer is powered on, or at link-up when no user is logged into the machine. User authentication is performed at link-up when the user is logged in.

Windows XP also supports guest authentication, but this is disabled by default. Refer to relevant Microsoft documentation for further information. The Windows XP machine can be configured to perform computer authentication at link-up even if user is logged in.

Authentication Server Side

The RADIUS server used for authentication must be EAP-capable. Consider the following when choosing a RADIUS server:

- Types of authentication methods supported on RADIUS, as mentioned previously.
- Need to support VSAs. Parameters such as `Extreme-Netlogin-Vlan-Name` (destination vlan for port movement after authentication) and `Extreme-NetLogin-Only` (authorization for network login only) are brought back as VSAs.
- Need to support both EAP and traditional user name-password authentication. These are used by network login and switch console login respectively.



NOTE

For information on how to use and configure your RADIUS server, refer [“Configuring the RADIUS Client” on page 872](#) and to the documentation that came with your RADIUS server.

Enabling and Disabling 802.1x Network Login

To enable 802.1x network login on the switch, use the following command:

```
enable netlogin dot1x
```

Any combination of types of authentication can be enabled on the same switch. At least one of the authentication types must be specified on the CLI.

To disable 802.1x network login on the switch, use the following command:

```
disable netlogin dot1x
```

To enable 802.1x network login on one or more ports, use the following command:

```
enable netlogin ports <portlist> dot1x
```

Network Login must be disabled on a port before you can delete a VLAN that contains that port. To disable 802.1x network login on one or more ports, use the following command:

```
disable netlogin ports <portlist> dot1x
```

You can set a reauthentication maximum counter value to indicate the number number of reauthentication trials after which the supplicant is denied access or given limited access. To configure the reauthentication counter values, use the following command:

```
configure netlogin dot1x timers
```

To unconfigure the reauthentication counter values, use the following command:

```
unconfigure netlogin dot1x guest-vlan
```

802.1x Network Login Configuration Example

The following configuration example shows the Extreme Networks switch configuration needed to support the 802.1x network login example.

**NOTE**

In the following sample configuration, any lines marked (Default) represent default settings and do not need to be explicitly configured.

```
create vlan "temp"
create vlan "corp"
configure vlan "default" delete ports 4:1-4:4

# Configuration Information for VLAN corp
# No VLAN-ID is associated with VLAN corp.
configure vlan "corp" protocol "ANY" (Default)
configure vlan "corp" ipaddress 10.203.0.224 255.255.255.0

# Configuration Information for VLAN Mgmt
configure vlan "Mgmt" ipaddress 10.10.20.30 255.255.255.0

# Network Login Configuration
configure netlogin vlan "temp"
enable netlogin dot1x
enable netlogin ports 1:10-1:14, 4:1-4:4 dot1x

# RADIUS Configuration
configure radius netlogin primary server 10.0.1.2 1812 client-ip 10.10.20.30 vr "VR-
Mgmt"
configure radius netlogin primary shared-secret purple
enable radius
```

The following example is for the FreeRADIUS server; the configuration might be different for your RADIUS server:

```
#RADIUS Server Setting, in this example the user name is eaptest
eaptest Auth-Type := EAP, User-Password == "eaptest"
Session-Timeout = 120,
Termination-Action =1
```

**NOTE**

For information about how to use and configure your RADIUS server, refer to [“Configuring the RADIUS Client” on page 872](#) and the documentation that came with your RADIUS server.

Configuring Guest VLANs

Ordinarily, a client that does not respond to 802.1x authentication remains disabled and cannot access the network. 802.1x authentication supports the concept of “guest VLANs” that allow such a supplicant (client) limited or restricted network access. If a supplicant connected to a port does not respond to the 802.1x authentication requests from the switch, the port moves to the configured guest VLAN. A port always moves untagged into the guest VLAN.

**NOTE**

The supplicant does not move to a guest VLAN if it fails authentication after an 802.1x exchange; the supplicant moves to the guest VLAN only if it does not respond to an 802.1x authentication request.

When the authentication server sends an 802.1x request to the supplicant, there is a specified time interval for the supplicant to respond. By default, the switch uses the supplicant response timer to authenticate the supplicant every 30 seconds for a maximum of three tries. If the supplicant does not respond within the specified time, the authentication server sends another request. After the third 802.1x request without a supplicant response, the port is placed in the guest VLAN, if the guest VLAN feature has been configured for the port. The number of authentication attempts is not a user-configured parameter.

If a supplicant on a port in the guest VLAN becomes 802.1x-capable, the switch starts processing the 802.1x responses from the supplicant. If the supplicant is successfully authenticated, the port moves from the guest VLAN to the destination VLAN specified by the RADIUS server. If the RADIUS server does not specify a destination VLAN, the port moves to the VLAN it belonged to before it was placed in the guest VLAN. After a port has been authenticated and moved to a destination VLAN, it is periodically re-authenticated. If the port fails authentication, it moves to the VLAN to which it belonged originally.

**NOTE**

A guest VLAN is not a normal network login VLAN. A guest VLAN performs authentication only if authentication is initiated by the supplicant.

This section describes the following topics:

- [Using Guest VLANs on page 779](#)
- [Guidelines for Configuring Guest VLANs on page 780](#)
- [Creating Guest VLANs on page 780](#)
- [Enabling Guest VLANs on page 781](#)
- [Modifying the Supplicant Response Timer on page 781](#)
- [Disabling Guest VLANs on page 781](#)
- [Unconfiguring Guest VLANs on page 781](#)
- [Displaying Guest VLAN Settings on page 781](#)

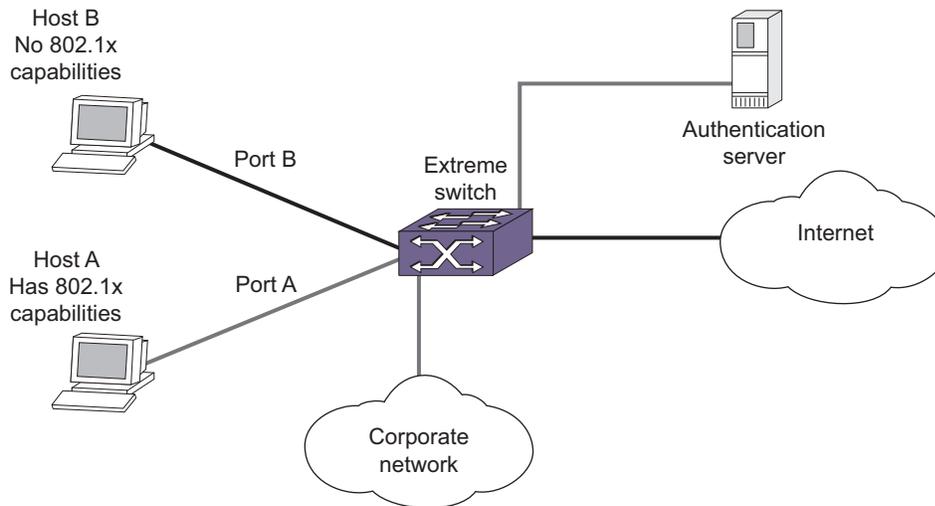
Using Guest VLANs

Suppose you have a meeting that includes company employees and visitors from outside the company. In this scenario, your employees have 802.1x enabled supplicants but your visitors do not. By configuring a guest VLAN, when your employees log into the network, they are granted network access (based on their user credentials and 802.1x enabled supplicants). However, when the visitors attempt to log into the network, they are granted limited network access because they do not have 802.1x enabled supplicant. The visitors might be able to reach the Internet, but they are unable to access the corporate network.

For example, in [Figure 98](#) Host A has 802.1x capability and Host B does not. When Host A is authenticated, it is given full access to the network. Host B does not have 802.1x capability and

therefore does not respond to 802.1x requests from the switch. If port B is configured with the guest VLAN, port B is moved to the guest VLAN. Then Host B will be able to access the Internet but not the corporate network. After Host B is equipped with 802.1x capability, it can be authenticated and allowed to be part of the corporate network.

Figure 98: Guest VLAN for Network Login



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Guidelines for Configuring Guest VLANs

Keep in mind the following guidelines when configuring guest VLANs:

- You must create a VLAN and configure it as a guest VLAN before enabling the guest VLAN feature.
- Configure guest VLANs only on network login ports with 802.1x enabled.
- Movement to guest VLANs is not supported on network login ports with MAC-based or web-based authentication.
- 802.1x must be the only authentication method enabled on the port for movement to guest VLAN.
- No supplicant on the port has 802.1x capability.

Creating Guest VLANs

If you configure a guest VLAN, and a supplicant has 802.1x disabled and does not respond to 802.1x authentication requests from the switch, the supplicant moves to the guest VLAN. Upon entering the guest VLAN, the supplicant gains limited network access.



NOTE

You can configure guest VLANs on a per port basis, which allows you to configure more than one guest VLAN per VR. In ExtremeXOS 11.5 and earlier, you can only configure guest VLANs on a per VR basis, which allows you to configure only one guest VLAN per VR.

To create a guest VLAN, use the following command:

```
configure netlogin dot1x guest-vlan <vlan_name> {ports <port_list>}
```

Enabling Guest VLANs

To enable the guest VLAN, use the following command:

```
enable netlogin dot1x guest-vlan ports [all | <ports>]
```

Modifying the Supplicant Response Timer

To modify the supplicant response timer, use the following command and specify the `supp-resp-timeout` parameter:

```
configure netlogin dot1x timers [{server-timeout <server_timeout>} {quiet-period <quiet_period>} {reauth-period <reauth_period>} {reauth-max <max_num_reauths>}] {supp-resp-timeout <supp_resp_timeout>}]
```

The default supplicant response timeout is 30 seconds, and the range is 1 to 120 seconds. The number of authentication attempts is not a user-configured parameter.

Disabling Guest VLANs

To disable the guest VLAN, use the following command:

```
disable netlogin dot1x guest-vlan ports [all | <ports>]
```

Unconfiguring Guest VLANs

To unconfigure the guest VLAN, use the following command:

```
unconfigure netlogin dot1x guest-vlan {ports <port_list> | <vlan_name>}
```

Displaying Guest VLAN Settings

To display the guest VLAN settings, use the following command:

```
show netlogin guest-vlan {vlan_name}
```

If you specify the `vlan_name`, the switch displays information for only that guest VLAN.

The output displays the following information in a tabular format:

- `Port`—Specifies the 802.1x enabled port configured for the guest VLAN.
- `Guest-vlan`—Displays guest VLAN name and status: enable/disable.
- `Vlan`—Specifies the name of the guest VLAN.

Post-authentication VLAN Movement

After the supplicant has been successfully authenticated and the port has been moved to a VLAN, the supplicant can move to a VLAN other than the one it was authenticated on. This occurs when the switch receives an Access-Accept message from the RADIUS server with a VSA that defines a new VLAN. The supplicant remains authenticated during this transition. This occurs on both untagged and tagged VLANs. For example, suppose a supplicant submits the required credentials for network access; however, it is not running the current, approved anti-virus software or it does not have the appropriate software updates installed. If this occurs, the supplicant is authenticated but has limited network access until the problem is resolved. After you update the supplicant's anti-virus software, or install the software updates, the RADIUS server re-authenticates the supplicant by sending ACCESS-ACCEPT

messages with the accompanying VLAN attributes, thereby allowing the supplicant to enter its permanent VLAN with full network access.

This is normal and expected behavior; no configuration is necessary.

802.1x Authentication and Network Access Protection

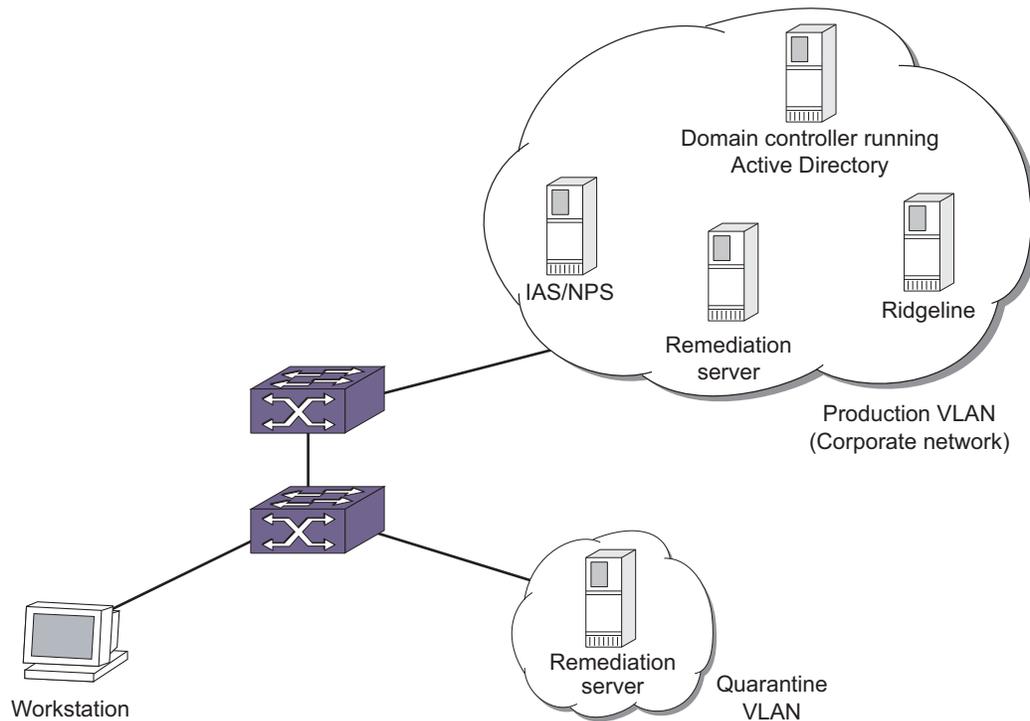
802.1x authentication in combination with Microsoft's Network Access Protection (NAP) provide additional integrity checks for end users and supplicants that attempt to access the network. NAP allows network administrators to create system health policies to ensure supplicants that access or communicate with the network meet administrator-defined system health requirements. For example, if a supplicant has the appropriate software updates or anti-virus software installed, the supplicant is deemed healthy and granted network access. On the other hand, if a supplicant does not have the appropriate software updates or anti-virus software installed, the supplicant is deemed unhealthy and is placed in a quarantine VLAN until the appropriate update or anti-virus software is installed. After the supplicant is healthy, it is granted network access. For more information about NAP, please refer to the documentation that came with your Microsoft Windows or Microsoft Server software.

To configure your network for NAP, the minimum required components are:

- Extreme Networks switches running ExtremeXOS 11.6 or later.
- RADIUS server that supports NAP (Microsoft Windows Vista operating system refers to this as a network policy server (NPS), formerly known as the internet authentication server (IAS)).
- Remediation servers that receive unhealthy supplicants. The remediation servers contain the appropriate software updates, anti-virus software, and so on to make a supplicant healthy.

In addition to the required hardware and software, you must configure NAP-specific VSAs on your RADIUS server. By configuring these VSAs, you ensure supplicant authentication and authorization to the network and the switch creates dynamic Access Control Lists (ACLs) to move unhealthy supplicants to the quarantine VLAN for remediation. For more information see, [“Using NAP-Specific VSAs to Authenticate 802.1x Supplicants” on page 784.](#)

Figure 99 displays a sample network that uses NAP to protect the network.

Figure 99: Sample Network Using NAP to Provide Enhanced Security

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Example Scenarios Using NAP

Using [Figure 99](#), the following two scenarios describe some sample actions taken when an 802.1x-enabled supplicant initiates a connection to the network. The scenarios assume the following:

- Scenario 1 has a healthy 802.1x-enabled supplicant.
- Scenario 2 has an unhealthy 802.1x-enabled supplicant.
- 802.1x network login has been configured and enabled on the switch.
- The RADIUS server has been configured using the NAP-specific VSAs for authenticating supplicants.
- The remediation servers have been configured with the appropriate software updates, anti-virus software, and so on.
- The Ridgeline server has been configured to receive traps from the switch. The traps sent from the switch inform Ridgeline of the state of the supplicant. In these scenarios, you configure Ridgeline as the syslog target.
- VLANs Production and Quarantine have already been created and configured.



NOTE

You can dynamically create the quarantine VLAN if you configure dynamic VLAN creation on the switch. For more information see, [“Configuring Dynamic VLANs for Network Login”](#) on page 800.

Scenario 1—Healthy Supplicant. The steps to authenticate a healthy supplicant are:

- 1 The 802.1x supplicant initiates a connection to the 802.1x network access server (NAS), which in this scenario is the Extreme Networks switch.
- 2 The supplicant passes its authentication credentials to the switch using PEAP and an inner authentication method such as MS-CHAPv2.
- 3 The RADIUS server requests a statement of health (SoH) from the supplicant.
Only NAP-capable supplicants create an SoH, which contains information about whether or not the supplicant is compliant with the system health requirements defined by the network administrator.
- 4 If the SoH indicates that the supplicant is healthy, the RADIUS server sends an Access-Accept message with a RADIUS VSA indicating which VLAN the healthy supplicant is moved to (in this example, the Production VLAN).
- 5 The switch authenticates the supplicant and moves it into the Production VLAN.
- 6 The switch sends a trap to Ridgeline indicating that the supplicant has been successfully authenticated and the VLAN into which it has been moved.

Scenario 2—Unhealthy Supplicant. The steps to authenticate an unhealthy supplicant are:

- 1 The 802.1x supplicant initiates a connection to the 802.1x network access server (NAS), which in this scenario is the Extreme Networks switch.
- 2 The supplicant passes its authentication credentials to the switch using PEAP and an inner authentication method such as MS-CHAPv2.
- 3 The RADIUS server requests a statement of health (SoH) from the supplicant.
Only NAP-capable supplicants create an SoH, which contains information about whether or not the supplicant is compliant with the system health requirements defined by the network administrator.
- 4 If the SoH indicates that the supplicant is unhealthy, the RADIUS server sends an Access-Accept message with RADIUS VSAs indicating which:
 - VLAN the unhealthy supplicant is moved to (in this example, the Quarantine VLAN)
 - Remediation server(s) the supplicant can get software updates, anti-virus software and so on to remediate itself
- 5 When the switch receives the VLAN and remediation server information from the RADIUS server, the switch:
 - Moves the supplicant into the Quarantine VLAN.
 - Applies ACLs to ensure the supplicant in the Quarantine VLAN can access only the remediation servers. All other traffic not originating/destined from/to the remediation servers is dropped.
 - Sends a trap to Ridgeline indicating that the supplicant has been authenticated but has restricted access in the Quarantine VLAN for remediation.
- 6 The supplicant connects to the remediation server to get software updates, anti-virus software, and so on to get healthy.
- 7 After the supplicant is healthy, it re-starts the authentication process and is moved to the Production VLAN, as a healthy supplicant with full network access.

Using NAP-Specific VSAs to Authenticate 802.1x Supplicants

Table 93 contains the VSA definitions for 802.1x network login in conjunction with devices and servers that support NAP. The Microsoft Vendor ID is 311.

**NOTE**

For more information about NAP and the VSAs supported by NAP, please refer to the documentation that came with your Microsoft operating system or server.

Table 93: NAP-Specific VSA Definitions for 802.1x Network Login

MS-Quarantine-State	45	Integer	Access-Accept	Indicates the network access level that the RADIUS server authorizes the user. The network access server (the switch) also enforces the network access level. A value of "0" gives the user full network access. A value of "1" gives the user limited network access. A value of "2" gives the user full network access within a specified time period.
MS-IPv4-Remediation-Servers	52	Integer	Access-Accept	Indicates the IP address(es) of the remediation server(s) that an unhealthy supplicant moves to in order to get healthy.

ACLs for Remediation Servers

The NAP VSA, MS-IPv4-Remediation-Servers, contains a list of IP addresses that an unhealthy and therefore quarantined supplicant should be allowed access to so that it can remediate itself and become healthy.

The way a quarantine is implemented on the switch is simply by moving the client/port to a user-designated 'quarantine' VLAN whose VLANID/Name is sent in the Access-Accept message. It is up to the user to ensure that the quarantine VLAN does indeed have limited access to the rest of the network. Typically, this can be done by disabling IP forwarding on that VLAN so no routed traffic can get out of that VLAN. Also, with dynamic VLAN creation, the quarantine VLAN being supplied by RADIUS could be dynamically created on the switch, once dynamic VLAN creation is enabled on it. The remediation server(s) would need to be accessible via the uplink port, regardless of whether the quarantine VLAN is pre-configured or dynamically created, since IP forwarding is not enabled on it.

To get around this restriction, network login has been enhanced so when a MS-Quarantine-State attribute is present in the Access-Accept message with extremeSessionStatus being either 'Quarantined' or 'On Probation,' then a 'deny all traffic' dynamic ACL will be applied on the VLAN. If such an ACL is already present on that VLAN, then no new ACL will be applied.

When the last authenticated client has been removed from the quarantine VLAN, then the above ACL will be removed.

Additionally, if the MS-IPv4-Remediation-Servers VSA is present in the Access-Accept message, for each IP address present in the VSA a 'permit all traffic to/from this IP address' ACL will be applied on the quarantine VLAN. This will allow traffic to/from the remediation servers to pass unhindered in the Quarantine VLAN while all other traffic will be dropped.

Web-Based Authentication

This section describes web-based network login. For web-based authentication, you need to configure the switch DNS name, default redirect page, session refresh, and logout-privilege. URL redirection requires the switch to be assigned a DNS name. The default name is `network-access.net`. Any DNS query coming to the switch to resolve switch DNS name in unauthenticated mode is resolved by the DNS server on the switch in terms of the interface (to which the network login port is connected to) IP address.

This section describes the following topics:

- [Enabling and Disabling Web-Based Network Login on page 786](#)
- [Configuring the Base URL on page 786](#)
- [Configuring the Redirect Page on page 787](#)
- [Configuring Session Refresh on page 787](#)
- [Configuring Logout Privilege on page 788](#)
- [Configuring the Login Page on page 788](#)
- [Customizable Authentication Failure Response on page 790](#)
- [Web-Based Network Login Configuration Example on page 791](#)
- [Web-Based Authentication User Login on page 792](#)

Enabling and Disabling Web-Based Network Login

To enable web-based network login on the switch, use the following command:

```
enable netlogin web-based
```

Any combination of types of authentication can be enabled on the same switch. At least one of the authentication types must be specified on the CLI.

To disable web-based network login on the switch, use the following command:

```
disable netlogin web-based
```

To enable web-based network login on one or more ports, use the following command:

```
enable netlogin ports <portlist> web-based
```

Network Login must be disabled on a port before you can delete a VLAN that contains that port. To disable web-based network login on one or more ports, use the following command:

```
disable netlogin ports <portlist> web
```

Configuring the Base URL

To configure the network login base URL, use the following command:

```
configure netlogin base-url <url>
```

Where `<url>` is the DNS name of the switch. For example, configure `netlogin base-url network-access.net` makes the switch send DNS responses back to the network login clients when a DNS query is made for `network-access.net`.

Configuring the Redirect Page

To configure the network login redirect page, use the following command:

```
configure netlogin redirect-page <url>
```

Where `<url>` defines the redirection information for the users after they have logged in. You must configure a complete URL starting with `http://` or `https://`

By default, the redirect URL value is “`http://www.extremenetworks.com`”.

You can also configure the redirect value to a specific port number, such as 8080. For example, you can configure the network login redirect page to the URL value “`http://www.extremenetworks.com:8080`”. The default port value is 80.

This redirection information is used only in case the redirection info is missing from RADIUS server. For example, `configure netlogin base-url http://www.extremenetworks.com` redirects all users to this URL after they get logged in.

To support https, you must first download and install the separate Extreme Networks SSH software module (`ssh.xmod`). This additional module allows you to configure both SSH2 and SSL on the switch. For more information about SSH2, see [Chapter 23, “Security.”](#) For information about installing the SSH module, see [Appendix B, “Software Upgrade and Boot Options.”](#)

Configuring Proxy Ports

To configure the ports to be hijacked and redirected, use the following commands:

```
configure netlogin add proxy-port <tcp_port> {http | https}
configure netlogin delete proxy-port
```

For each hijacked or proxy port, you must specify whether the port is to be used for HTTP or HTTPS traffic. No more than five hijack or proxy ports are supported for HTTP in addition to port 80 (for HTTP) and port 443 (for HTTPS), both of which cannot be deleted.

Configuring Session Refresh

To enable or disable the network login session refresh, use one of the following commands:

```
enable netlogin session-refresh {<refresh_minutes>}
disable netlogin session-refresh
```

Where `<minutes>` ranges from 1 - 255. The default setting is 3 minutes. `enable netlogin session-refresh` and `configure netlogin session-refresh` makes the logout window refresh itself at every configured time interval. Session refresh is enabled by default. When you configure the network login session refresh for the logout window, ensure that the FDB aging timer is greater than the network login session refresh timer.



NOTE

If an attempt is made to authenticate the client in a non-existent VLAN, and the move fail action setting is `authenticate`, then the client is successfully authenticated in the port's original VLAN, but subsequent session refreshes fail and cause the client to become unauthenticated.

When web-based Network login is configured with proxy ports and session-refresh are also enabled, you must configure the web browser to bypass the web proxy server for the IP address of the VLAN into which the client moves after authentication.

Configuring Logout Privilege

To enable or disable network login logout privilege, use one of the following commands:

```
enable netlogin logout-privilege
disable netlogin logout-privilege
```

These commands turn the privilege for network login users to logout by popping up (or not popping up) the logout window. `Logout-privilege` is enabled by default.

You can configure the number of times a refresh failure is ignored before it results in the client being unauthenticated by using the following commands:

```
configure netlogin allowed-refresh-failures
unconfigure netlogin allowed-refresh-failures
```

You can set the number of failures to be from between 0 and 5. The default number of logout failures is 0.

Configuring the Login Page

You can fully customize the HTML login page and also add custom embedded graphical images to it. This page and the associated graphics must be uploaded to the switch so that they can be served up as the initial login page at the base URL. Both HTTP and HTTPS are supported as a means of authenticating the user via the custom page.

In general, the steps for setting up a custom login page and graphical images (if any) are as follows:

- 1 Write the custom web-page.
- 2 TFTP the page and any embedded JPEG or GIF graphical images that it references onto the switch.
- 3 Enable and configure web-based Network Login on the switch. When the custom page is present on the switch, it will over-ride the configured banner.

Configuring a Network Login Banner

To configure a banner on a network login screen, use the following command:

```
configure netlogin banner <banner>
```

To display configured banners from the network login screen, use the following command:

```
show netlogin banner
```

To clear configured network login banners, use the following command:

```
unconfigure netlogin banner
```

Login Page Contents

The customized web-page must have the file name `netlogin_login_page.html`. While the contents of the page are left up to the customer, they *must* contain the following elements:

- An HTML submit form with `action="/hello"` and `method="post"` that is used to send the Network Login username and password to the switch. The form must contain the following:
 - A username input field with `name="extremenetloginuser"`
 - A password input field with `name="extremenetloginpassword"`
- Optionally, one or more graphical images embedded using the tags


```
 or
 or

```

 where `<xxx>` is user-configurable.

The following is a sample custom page, where the embedded graphical image is named `netlogin_welcome.jpg`:

```
<html lang="en">
<head>
<title>Network Login Page</title>
</head>
<body>
  <form action="/hello" method="post">
    
    <br/>
    Please log in:
    <br/>
    User:
    <input type="text" name="extremenetloginuser" />
    <br/>
    Password:
    <input type="password" name="extremenetloginpassword" />
    <br/>
    <input type="submit" value="Submit" />
  </form>
</body>
</html>
```

Uploading the Login File to the Switch

To upload the page and the JPEG/GIF files, the switch TFTP command must be used. For example, assuming the page resides on a TFTP server with IP address 10.255.49.19, the command used would be

```
BD-8810.1 # tftp get 10.255.49.19 netlogin_login_page.html
```

General Guidelines

The following general guidelines are applicable to the login page:

- When the custom web page is not present on the switch, the system falls back to the using the default `banner`. The web page may be added (or removed) from the switch at any time, at which point the switch will stop (or start) using the banner.
- The graphical image file names referenced in the web page must not have any path information prepended.

- Both uppercase and lowercase names (or a mixture) for the graphical image filenames are supported, but the user and password tag names should be either all uppercase or all lowercase, not a mixture of the two.
- More than one form may exist on the page. This can be useful when, for example, in addition to the main username and password that is typed in by the user, an additional special username and password needs to be auto-filled and sent. For example, this could be used when end users without a valid username or password need to be given restricted access to the network.

Limitations

The following limitations apply to the login page:

- When the client is in the unauthenticated state, any embedded URLs in the custom page are inaccessible to it.
- Only JPEG and GIF graphical images are supported.
- It is the web page writer's responsibility to write the HTML page correctly and without errors.
- Only TFTP is supported as a method to upload the web-page and graphical images to the switch.

Customizable Authentication Failure Response

In the event of web-based network login authentication failure, you can use a custom authentication failure page to recover. When a customized login page is in effect, 'by default, any authentication failure results in the following failure response being delivered to the browser:

Login Incorrect. [Click here](#) to try again.

Clicking on the indicated link will bring the user back to the initial custom login page.

You may choose to over ride the above default response with a custom one. This custom failure response page must be uploaded to the switch using TFTP with the name `netlogin_login_fail_page.html`. When authentication fails, the switch responds with this page. If the page is deleted from the switch, the response reverts back to the default.

The same graphical images that are uploaded to the switch for the custom login page can also be embedded in the custom authentication failure page.



NOTE

The custom authentication failure page can be used only when authentication is being done via the custom login page.

Customizable Graphical Image in Logout Popup Window

You can embed a graphical image in the logout popup window. This image appears in the window in addition to the text that is displayed. The image must be TFTPed to the switch in the same manner as the custom login image, and must have the filename `netlogin_logout_image.jpg` or `netlogin_logout_image.gif` (depending on whether the image is JPEG or GIF). If no such image is present on the switch, then the logout popup contains only text.

Web-Based Network Login Configuration Example

The following configuration example shows both the Extreme Networks switch configuration and the RADIUS server entries needed to support the example. VLAN *corp* is assumed to be a corporate subnet which has connections to DNS, WINS servers, network routers, and so on. VLAN *temp* is a temporary VLAN and is created to provide connections to unauthenticated network login clients. Unauthenticated ports belong to the VLAN *temp*. This kind of configuration provides better security as unauthenticated clients do not connect to the corporate subnet and will not be able to send or receive any data. They have to get authenticated in order to have access to the network.

- **ISP Mode**—Network login clients connected to ports 1:10 - 1:14, VLAN *corp*, will be logged into the network in ISP mode. This is controlled by the fact that the VLAN in which they reside in unauthenticated mode and the RADIUS server Vendor Specific Attributes (VSA), `Extreme-Netlogin-Vlan`, are the same, *corp*. So there will be no port movement. Also if this VSA is missing from RADIUS server, it is assumed to be ISP Mode.
- **Campus Mode**—On the other hand, clients connected to ports 4:1 - 4:4, VLAN *temp*, will be logged into the network in Campus mode since the port will move to the VLAN *corp* after getting authenticated. A port moves back and forth from one VLAN to the other as its authentication state changes.

Both ISP and Campus mode are not tied to ports but to a user profile. In other words, if the VSA `Extreme:Extreme-Netlogin-Vlan` represents a VLAN different from the one in which the user currently resides, then VLAN movement will occur after login and after logout. In following example, it is assumed that campus users are connected to ports 4:1-4:4, while ISP users are logged in through ports 1:10-1:14.



NOTE

In the following sample configuration, any lines marked (Default) represent default settings and do not need to be explicitly configured.

```
create vlan "temp"
create vlan "corp"
configure vlan "default" delete ports 4:1-4:4
enable ipforwarding

# Configuration Information for VLAN temp
# No VLAN-ID is associated with VLAN temp.
configure vlan "temp" ipaddress 198.162.32.10 255.255.255.0

# Configuration Information for VLAN corp
# No VLAN-ID is associated with VLAN corp.
configure vlan "corp" ipaddress 10.203.0.224 255.255.255.0
configure vlan "corp" add port 1:10 untagged
configure vlan "corp" add port 1:11 untagged
configure vlan "corp" add port 1:12 untagged
configure vlan "corp" add port 1:13 untagged
configure vlan "corp" add port 1:14 untagged

# Network Login Configuration
configure vlan "temp" dhcp-address-range 198.162.32.20 - 198.162.32.80
configure vlan "temp" dhcp-options default-gateway 198.162.32.1
configure vlan "temp" dhcp-options dns-server 10.0.1.1
configure vlan "temp" dhcp-options wins-server 10.0.1.85
```

```
configure netlogin vlan "temp"
enable netlogin web-based
enable netlogin ports 1:10-1:14,4:1-4:4 web-based
configure netlogin base-url "network-access.net" (Default)
configure netlogin redirect-page http://www.extremenetworks.com (Default)
enable netlogin logout-privilege (Default)
disable netlogin session-refresh 3 (Default)

# DNS Client Configuration
configure dns-client add name-server 10.0.1.1
configure dns-client add name-server 10.0.1.85

#RADIUS Client Configuration
configure radius netlogin primary server 10.0.1.2 1812 client-ip 10.10.20.30 vr "Vr-
Mgmt"
configure radius netlogin primary shared-secret purple
enable radius
```

For this example, the following lines (for a FreeRADIUS server) should be added to the RADIUS server *users* file for each user:

```
Extreme:Extreme-Netlogin-Only = Enabled (if no CLI authorization)
Extreme:Extreme-Netlogin-Vlan = "corp" (destination vlan for CAMPUS mode network
login)
```

**NOTE**

For information about how to use and configure your RADIUS server, refer [“Configuring the RADIUS Client” on page 872](#) and to the documentation that came with your RADIUS server.

Web-Based Authentication User Login

To use web-based authentication:

- 1 Set up the Windows IP configuration for DHCP.
- 2 Plug into the port that has web-based network login enabled.
- 3 Log in to Windows.
- 4 Release any old IP settings and renew the DHCP lease.

This is done differently depending on the version of Windows the user is running:

- **Windows 9x**—Use the `winipcfg` tool. Choose the Ethernet adapter that is connected to the port on which network login is enabled. Use the buttons to release the IP configuration and renew the DHCP lease.
- **Windows NT/2000/XP**—Use the `ipconfig` command line utility. Use the command `ipconfig/release` to release the IP configuration and `ipconfig/renew` to get the temporary IP address from the switch. If you have more than one Ethernet adapter, specify the adapter by using a number for the adapter following the `ipconfig` command. You can find the adapter number using the command `ipconfig/all`.

**NOTE**

The idea of explicit release/renew is required to bring the network login client machine in the same subnet as the connected VLAN. When using we-based authentication, this requirement is mandatory after every logout and before login again as the port moves back and forth between the temporary and permanent VLANs.

At this point, the client will have its temporary IP address. In this example, the client should have obtained the an IP address in the range 198.162.32.20 - 198.162.32.80.

- 5 Bring up the browser and enter any URL as `http://www.123.net` or `http://1.2.3.4` or switch IP address as `http://<IP address>/login` (where IP address could be either temporary or Permanent VLAN Interface for Campus Mode). URL redirection redirects any URL and IP address to the network login page. This is significant where security matters most, as no knowledge of VLAN interfaces is required to be provided to network login users, as they can login using a URL or IP address.

**NOTE**

URL redirection requires that the switch is configured with a DNS client.

A page opens with a link for Network Login.

- 6 Click the Network Login link.

A dialog box opens requesting a user name and password.

- 7 Enter the user name and password configured on the RADIUS server.

After the user has successfully logged in, the user will be redirected to the URL configured on the RADIUS server.

During the user login process, the following takes place:

- Authentication is done through the RADIUS server.
- After successful authentication, the connection information configured on the RADIUS server is returned to the switch:
 - The permanent VLAN
 - The URL to be redirected to (optional)
 - The URL description (optional)
- The port is moved to the permanent VLAN.

You can verify this using the `show vlan` command. For more information on the `show vlan` command, see “[Displaying VLAN Information](#)” on page 537.

After a successful login has been achieved, there are several ways that a port can return to a non-authenticated, non-forwarding state:

- The user successfully logs out using the logout web browser window.
- The link from the user to the switch’s port is lost.
- There is no activity on the port for 20 minutes.
- An administrator changes the port state.

**NOTE**

Because network login is sensitive to state changes during the authentication process, Extreme Networks recommends that you do not log out until the login process is complete. The login process is complete when you receive a permanent address.

MAC-Based Authentication

MAC-based authentication is used for supplicants that do not support a network login mode, or supplicants that are not aware of the existence of such security measure, for example an IP phone.

If a MAC address is detected on a MAC-based enabled network login port, an authentication request is sent once to the AAA application. AAA tries to authenticate the MAC address against the configured RADIUS server and its configured parameters (timeout, retries, and so on) or the local database.

In a MAC-based authentication environment the authentication verification is done only once at MAC address detection. However, forced reauthentication is allowed through the Session-Timeout VSA supplied by RADIUS. When this VSA is present the switch re-authenticates the client based on the value supplied by the VSA. If no VSA is present, there is no re-authentication.

The credentials used for this are the supplicants MAC address in ASCII representation, and a locally configured password on the switch. If no password is configured, the MAC address is used as the password. You can also group MAC addresses together using a mask.

You can configure a MAC list or a table of MAC entries to filter and authenticate clients based on their MAC addresses. If there a match is found in the table of MAC entries, authentication occurs. If no match is found in the table of MAC entries, and a default entry exists, the default will be used to authenticate the client. All entries in the list are automatically sorted in longest prefix order. All passwords are stored and showed encrypted.

You can associate a MAC address with one or more ports. By learning a MAC address, the port confirms the supplicant before sending an authorization request to the RADIUS server. This additional step protects your network against unauthorized supplicants because the port accepts only authorization requests from the MAC address learned on that port. The port blocks all other requests that do not have a matching entry.

This section describes the following topics:

- [Enabling and Disabling MAC-Based Network Login on page 795](#)
- [Associating a MAC Address to a Specific Port on page 795](#)
- [Adding and Deleting MAC Addresses on page 795](#)
- [Displaying the MAC Address List on page 796](#)
- [Configuring Reauthentication Period on page 796](#)
- [Secure MAC Configuration Example on page 796](#)
- [MAC-Based Network Login Configuration Example on page 797](#)

Enabling and Disabling MAC-Based Network Login

To enable MAC-based network login on the switch, use the following command:

```
enable netlogin mac
```

Any combination of types of authentication can be enabled on the same switch. At least one of the authentication types must be specified on the CLI.

To disable MAC-based network login on the switch, use the following command:

```
disable netlogin mac
```

To enable MAC-based network login on one or more ports, use the following command:

```
enable netlogin ports <portlist> mac
```

Network Login must be disabled on a port before you can delete a VLAN that contains that port. To disable MAC-based network login on one or more ports, use the following command:

```
disable netlogin ports <portlist> mac
```

Associating a MAC Address to a Specific Port

You can configure the switch to accept and authenticate a client with a specific MAC address. Only MAC addresses that have a match for the specific ports are sent for authentication. For example, if you associate a MAC address with one or more ports, only authentication requests for that MAC address received on the port(s) are sent to the configured RADIUS server or local database. The port(s) block all other authentication requests that do not have a matching entry. This is also known as secure MAC.

To associate a MAC address with one or more ports, specify the `ports` option when using the following command:

```
configure netlogin add mac-list [<mac> {<mask>} | default] {encrypted} {<password>}  
{ports <port_list>}
```

You must enable MAC-based network login on the switch and the specified ports. If MAC-based network login is not enabled on the specified port(s), the switch displays a warning message similar to the following:

```
WARNING: Not all specified ports have MAC-Based NetLogin enabled.
```

For a sample configuration, see [“Secure MAC Configuration Example” on page 796](#).

Adding and Deleting MAC Addresses

To add a MAC address to the table, use the following command:

```
configure netlogin add mac-list [<mac> {<mask>} | default] {encrypted} {<password>}  
{ports <port_list>}
```

To remove a MAC address from the table, use the following command:

```
configure netlogin delete mac-list [<mac> {<mask>} | default]
```

Displaying the MAC Address List

To display the MAC address table, use the following command:

```
show netlogin mac-list
```

When a client needs authentication the best match will be used to authenticate to the server.

MAC-based authentication is VR aware, so there is one MAC list per VR.

Assume we have a supplicant with MAC address 00:04:96:05:40:00, and the switch has the following table:

MAC Address/Mask	Password (encrypted)	Port (s)
00:00:00:00:00:10/48	<not configured>	1:1-1:5
00:00:00:00:00:11/48	<not configured>	1:6-1:10
00:00:00:00:00:12/48	<not configured>	any
00:01:30:70:0C:00/48	yaqu	any
00:01:30:32:7D:00/48	ravdqsr	any
00:04:96:00:00:00/24	<not configured>	any

The user name used to authenticate against the RADIUS server would be “000496000000”, as this is the supplicants MAC address with the configured mask applied.

Note that the commands are VR aware, and therefore one MAC list table exists per VR.

Configuring Reauthentication Period

To configure the reauthentication period for network login MAC-based authentication, use the following commands:

```
configure netlogin mac timers reauth-period
```

This timer is applicable only in the case where the client is authenticated in authentication failure vlan or authentication service unavailable vlan and the RADIUS server provides no session-timeout attribute during authentication. If the switch does receive the session-timeout attribute during authentication, the switch uses that value to set the reauthentication period. For more information on RADIUS server attributes, see [“Configuring the RADIUS Client” on page 872](#).

Secure MAC Configuration Example

The following configuration example shows how to configure secure MAC on your Extreme Networks switch. To configure secure MAC:

- Create a VLAN used for network login.
- Configure the VLAN for network login.
- Enable MAC-based network login on the switch.
- Enable MAC-based network login on the ports used for authentication.
- Specify one or more ports to accept authentication requests from a specific MAC address.

In the following example, authentication requests from MAC address:

- 00:00:00:00:00:10 are only accepted on ports 1:1 through 1:5
- 00:00:00:00:00:11 are only accepted on ports 1:6 through 1:10
- 00:00:00:00:00:12 are accepted on all other ports

```
create vlan nlvlan
configure netlogin vlan nlvlan
enable netlogin mac
enable netlogin ports 1:1-1:10 mac
configure netlogin add mac-list 00:00:00:00:00:10 ports 1:1-1:5
configure netlogin add mac-list 00:00:00:00:00:11 ports 1:6-1:10
configure netlogin add mac-list 00:00:00:00:00:12
```

To view your network login configuration, use one of the following commands:

- `show netlogin {port <portlist> vlan <vlan_name>} {dot1x {detail}} {mac} {web-based}`
- `show netlogin mac-list`

MAC-Based Network Login Configuration Example

The following configuration example shows the Extreme Networks switch configuration needed to support the MAC-based network login example.

```
create vlan "temp"
create vlan "corp"
configure vlan "default" delete ports 4:1-4:4

# Configuration Information for VLAN corp
# No VLAN-ID is associated with VLAN corp.
configure vlan "corp" ipaddress 10.203.0.224 255.255.255.0

# Network Login Configuration
configure netlogin vlan "temp"
enable netlogin mac
enable netlogin ports 4:1-4:4 mac
configure netlogin add mac-list default <password>

# RADIUS Client Configuration
configure radius netlogin primary server 10.0.1.2 1812 client-ip 10.10.20.30 vr "VR-Mgmt"
configure radius netlogin primary shared-secret purple
enable radius
```

The following example is a *users* file entry for a specific MAC address on a FreeRADIUS server:

```
00E018A8C540 Auth-Type := Local, User-Password == "00E018A8C540"
```



NOTE

For information about how to use and configure your RADIUS server, refer to [“Configuring the RADIUS Client” on page 872](#) and the documentation that came with your RADIUS server.

Additional Network Login Configuration Details

This section describes additional, optional network login configurations. These configurations are not required to run network login; however, depending on your network settings and environment, you can use the commands described in this section to enhance your network login settings.

Review the earlier sections of this chapter for general information about network login and information about MAC-based, web-based, and 802.1x authentication methods.

This section describes the following topics:

- [Configuring Network Login MAC-Based VLANs on page 798](#)
- [Configuring Dynamic VLANs for Network Login on page 800](#)
- [Configuring Network Login Port Restart on page 802](#)
- [Authentication Failure and Services Unavailable Handling on page 803](#)

Configuring Network Login MAC-Based VLANs

Currently, network login allows only a single, untagged VLAN to exist on a port. This limits the flexibility for untagged supplicants because they must be in the same VLAN.

BlackDiamond 8800 and Summit family switches support network login MAC-based VLANs. Network login MAC-based VLANs allow a port assigned to a VLAN to operate in a MAC-based fashion. This means that each individual untagged supplicant, identified by its MAC address, can be in different VLANs.

Network login MAC-based VLAN utilizes VSA information from both the network login local database and the RADIUS server. After successfully performing the Campus mode operation, the supplicant is added untagged to the destination VLAN.

To support this feature, you must configure the network login port's mode of operation.

Network Login MAC-Based VLANs Rules and Restrictions

This section summarizes the rules and restrictions for configuring network login MAC-based VLANs:

- You must configure and enable network login on the switch and before you configure network login MAC-based VLANs.

If you attempt to configure the port's mode of operation before enabling network login, the switch displays an error message similar to the following:

```
ERROR: The following ports do not have NetLogin enabled; 1
```

- On ExtremeXOS versions prior to 12.0 on switches other than the Summit family, 10 Gigabit Ethernet ports such as those on the 10G4X I/O module and the uplink ports on the Summit family of switches do not support network login MAC-based VLANs.

If you attempt to configure network login MAC-based VLANs on 10 Gigabit Ethernet ports, the switch displays an error message similar to the following:

```
ERROR: The following ports do not support the MAC-Based VLAN mode; 1, 2, 10
```

In ExtremeXOS version 12.0 and later, on the SummitStack, and Summit family switches, you can configure mac-based-VLANs on 10 Gigabit Ethernet ports.

- You can have a maximum of 1,024 MAC addresses per I/O module or per Summit family switch.

Configuring the Port Mode

To support network login MAC-based VLANs on a network login port, you must configure that port's mode of operation. To specify MAC-based operation, use the following command and specify `mac-based-vlans`:

```
configure netlogin ports [all | <port_list>] mode [mac-based-vlans | port-based-vlans]
```

By default, the network login port's mode of operation is `port-based-vlans`. If you modify the mode of operation to `mac-based-vlans` and later disable all network login protocols on that port, the mode of operation automatically returns to `port-based-vlans`.

When you change the network login port's mode of operation, the switch deletes all currently known supplicants from the port and restores all VLANs associated with that port to their original state. In addition, by selecting `mac-based-vlans`, you are unable to manually add or delete untagged VLANs from this port. Network login now controls these VLANs.

With network login MAC-based operation, every authenticated client has an additional FDB flag that indicates a translation MAC address. If the supplicant's requested VLAN does not exist on the port, the switch adds the requested VLAN.

Displaying Network Login MAC-Based VLAN Information

The following commands display important information for network login MAC-based VLANs.

FDB Information. To view FDB entries, use the following command:

```
show fdb netlogin [all | mac-based-vlans]
```

By specifying `netlogin`, you see only FDB entries related to network login or network login MAC-based VLANs. The flags associated with network login include:

- `v`—Indicates the FDB entry was added because the port is part of a MAC-Based virtual port/VLAN combination
- `n`—Indicates the FDB entry was added by network login

VLAN and Port Information. To view the VLANs that network login adds temporarily in MAC-based mode, use the following command:

```
show ports <port_list> information detail
```

By specifying `information` and `detail`, the output displays the temporarily added VLANs in network login MAC-based mode. To confirm this, review the following output of this command:

- `VLAN cfg`—The term MAC-based appears next to the tag number.
- `Netlogin port mode`—This output was added to display the port mode of operation. Mac based appears and the network login port mode of operation.

To view information about the ports that are temporarily added in MAC-based mode for network login, due to discovered MAC addresses, use the following command:

```
show vlan detail
```

By specifying `detail`, the output displays detailed information including the ports associated with the VLAN. The flags associated with network login include:

- `a`—Indicates that egress traffic is allowed for network login.
- `u`—Indicates that egress traffic is not allowed for network login.

- `m`—Indicates that the network login port operates in MAC-based mode.

**NOTE**

If network login is enabled together with STP, the 'a' and 'u' flags are controlled by network login only when the STP port state is 'Forwarding.'

Network Login MAC-Based VLAN Example

The following example configures the network login MAC-based VLAN feature:

```
create vlan users12
create vlan nlvlan
configure netlogin vlan nlvlan
enable netlogin mac
enable netlogin ports 1:1-1:10 mac
configure netlogin ports 1:1-1:10 mode mac-based-vlans
configure netlogin add mac-list default MySecretPassword
```

Expanding upon the previous example, you can also utilize the local database for authentication rather than the RADIUS server:

```
create netlogin local-user 000000000012 vlan-vsa untagged default
create netlogin local-user 000000000010 vlan-vsa untagged users12
```

For more information about local database authentication, see [“Local Database Authentication” on page 772](#).

Configuring Dynamic VLANs for Network Login

During an authentication request, network login receives a destination VLAN (if configured on the RADIUS server) to put the authenticated user in. The VLAN must exist on the switch for network login to authenticate the client on that VLAN.

You can configure the switch to dynamically create a VLAN after receiving an authentication response from a RADIUS server. A dynamically created VLAN is only a Layer 2 bridging mechanism; this VLAN does not work with routing protocols to forward traffic. If configured for dynamic VLAN creation, the switch automatically creates a supplicant VLAN that contains both the supplicant's physical port and one or more uplink ports. After the switch unauthenticates all of the supplicants from the dynamically created VLAN, the switch deletes that VLAN.

**NOTE**

Dynamically created VLANs do not support the session refresh feature of web-based network login because dynamically created VLANs do not have an IP address.

By dynamically creating and deleting VLANs, you minimize the number of active VLANs configured on your edge switches. In addition, the dynamic VLAN name can be stored on the RADIUS server and supplied to the switch during authentication, simplifying switch management. A key difference between dynamically created VLANs and other VLANs is that the switch does not save dynamically created VLANs. Even if you use the `save` command, the switch does not save a dynamically created VLAN.

After you configure network login on the switch, the two steps to configure dynamic VLANs are:

- Specifying the tagged uplink port(s) to be added to each dynamically created VLAN
- Enabling the switch to create dynamic VLANs

Specifying the Uplink Ports

The uplink ports send traffic to and from the supplicants from the core of the network. Uplink ports should not be configured for network login (network login is disabled on uplink ports).

To specify one or more ports as tagged uplink ports that are added to the dynamically created VLAN, use the following command:

```
configure netlogin dynamic-vlan uplink-ports [<port_list> | none]
```

By default, the setting is none.

If you specify an uplink port with network login enabled, the configuration fails and the switch displays an error message similar to the following:

```
ERROR: The following ports have NetLogin enabled: 1, 2
```

If this occurs, select a port with network login disabled.

Enabling Dynamic VLANs for Network Login

To enable the switch to create dynamic VLANs, use the following command:

```
configure netlogin dynamic-vlan [disable | enable]
```

By default, the setting is disabled. When enabled, the switch dynamically creates VLANs. Remember, dynamically created VLANs are not permanent or user-created VLANs. The switch uses the VLAN ID supplied by the RADIUS attributes (as described below) to create the VLAN. The switch only creates a dynamic VLAN if the requested VLAN, indicated by the VLAN ID, does not currently exist on the switch.

The RADIUS server uses VSAs to forward VLAN information. The forwarded information can include only a VLAN ID (no VLAN name). The following list specifies the supported VSAs for configuring dynamic VLANs:

- Extreme: Netlogin-VLAN-ID (VSA 209)
- Extreme: Netlogin-Extended-VLAN (VSA 211)
- IETF: Tunnel-Private-Group-ID (VSA 81)



NOTE

If the ASCII string contains only numbers, it is interpreted as the VLAN ID. Dynamic VLANs support only numerical VLAN IDs; VLAN names are not supported.

For more information on Extreme Networks VSAs, see [“Extreme Networks VSAs” on page 879](#).

The switch automatically generates the VLAN name in the following format: NLD_<TAG> where <TAG> specifies the VLAN ID. For example, a dynamic VLAN with an ID of 10 has the name NLD_0010.

**NOTE**

Like all VLAN names, dynamic VLAN names are unique. If you create a VLAN and use the name of an existing dynamic VLAN, the switch now sees the dynamic VLAN as a user-created VLAN and will save this VLAN to the switch configuration. If this occurs, the switch does not delete the VLAN after the supplicants are authenticated and moved to the permanent VLAN.

Dynamic VLAN Example with Web-Based Network Login

After you finish the web-based network login configuration as described in “[Web-Based Network Login Configuration Example](#)” on page 791, complete the dynamic VLAN configuration by:

- Assigning one or more non-network-login ports as uplink ports

**NOTE**

Do not enable network login on uplink ports. If you specify an uplink port with network login enabled, the configuration fails and the switch displays an error message.

- Enabling the switch to dynamically create VLANs

Whether you have MAC-based, web-based, or 802.1x authentication, you use the same two commands to configure dynamic VLANs on the switch.

The following example configures dynamic VLANs on the switch:

```
configure netlogin dynamic-vlan uplink ports 2:1-2:2
configure netlogin dynamic-vlan enable
```

Displaying Dynamic VLAN Information

To display summary information about all of the VLANs on the switch, including any dynamically VLANs currently operating on the switch, use the following command:

```
show vlan
```

If the switch has dynamically created VLANs, the VLAN name begins with SYS_NLD_.

To display the status of dynamic VLAN configuration on the switch, use the following command:

```
show netlogin
```

The switch displays the current state of dynamic VLAN creation (enabled or disabled) and the uplink port(s) associated with the dynamic VLAN.

Configuring Network Login Port Restart

You can configure network login to restart specific network-login-enabled ports when the last authenticated supplicant unauthenticates, regardless of the configured authentication methods on the port. This feature, known as network login port restart, is available with all network login authentication methods although is most practical with web-based network login. This section describes how this feature behaves with web-based network login; MAC-based and 802.1x network login do not experience any differences in behavior if you enable network login port restart.

Currently with web-based network login, if you have an authenticated supplicant and log out of the network, you must manually release the IP address allocated to you by the Dynamic Host Control Protocol (DHCP) server. The DHCP server dynamically manages and allocates IP addresses to supplicants. When a supplicant accesses the network, the DHCP server provides an IP address to that supplicant. DHCP cannot renegotiate their leases, which is why you must manually release the IP address.

For example, if the idle timer expires on the switch, the switch disconnects your network session. If this occurs, it may be unclear why you are unable to access the network. After you manually renew the IP address, you are redirected to the network login page and can log back into the network. To solve this situation in a single supplicant per port environment, port restart triggers the DHCP client on the PC to restart the DHCP address assignment process.

Guidelines for Using Network Login Port Restart

Configure network login port restart on ports with directly attached supplicants. If you use a hub to connect multiple supplicants, only the last unauthenticated supplicant causes the port to restart. Although the hub does not inflict harm to your network, in this situation, the previously unauthenticated supplicants do not get the benefit of the port restart configuration.

Enabling Network Login Port Restart

To enable network login port restart, use the following command:

```
configure netlogin ports [all | <port_list>] restart
```

Disabling Network Login Port Restart

To disable network login port restart, use the following command:

```
configure netlogin ports [all | <port_list>] no-restart
```

Displaying the Port Restart Configuration

To display the network login settings on the port, including the configuration for port restart, use the following command:

```
show netlogin port <port_list>
```

Output from this command includes the enable/disable state for network login port restart.

Authentication Failure and Services Unavailable Handling

ExtremeXOS provides the following features for handling network login authentication failures, and for handling instances of services unavailable:

- [Configuring Authentication Failure VLAN](#)
- [Configuring Authentication Services Unavailable VLAN](#)
- [Configuring Reauthentication Period](#) (for more information see [configure netlogin mac timers reauth-period](#))

You can use these features to set and control the response to network login authentication failure and instances of services unavailable.

Configuring Authentication Failure VLAN

When a network login client fails authentication, it is moved to authentication failure VLAN and given restricted access. To configure the authentication failure VLAN, use the following commands:

```
configure netlogin authentication failure vlan
unconfigure netlogin authentication failure vlan
enable netlogin authentication failure vlan ports
disable netlogin authentication failure vlan ports
```

Use the command `netlogin authentication failure vlan` to configure authentication failure VLAN on network-login-enabled ports. When a supplicant fails authentication, it is moved to the authentication failure VLAN and is given limited access until it passes the authentication.

Through either a RADIUS or local server, the other database is used to authenticate the client depending on the authentication database order for that particular network login method (`mac`, `web` or `dot1x`). If the final result is authentication failure and if the authentication failure VLAN is configured and enabled on that port, then the client is moved there.

For example, if the network login MAC authentication database order is `local`, `radius` and the authentication of a MAC client fails through local database, then the RADIUS server is used to authenticate. If the RADIUS server also fails authentication, the client is moved to the authentication failure VLAN. This applies for all authentication database orders (`radius, local`; `local, radius`; `radius; local`).

In the above example if authentication through local fails but passes through the RADIUS server, the client is moved to appropriate destination VLAN. If the local server authentication fails and the RADIUS server is not available, the client is *not* moved to authentication failure VLAN.

Dependency on authentication database order . There are four different authentication orders which can be configured per authentication method. These four orders are the following:

- RADIUS
- Local
- RADIUS, Local
- Local, RADIUS

For each authentication order, the end result is considered in deciding whether to authenticate the client through the authentication failure VLAN or the authentication service unavailable VLAN (if configured).

For example, if the authentication order is `radius, local`, with the RADIUS server unavailable, and local authentication failed, the client is authenticated in the authentication failure VLAN (if one is configured on the port).

For local authentication, if the user is not created in the local database, it is considered as service unavailable. If the user is configured but the password does not match, it is considered as an authentication failure.

For RADIUS server authentication, if for some reason the user cannot be authenticated due to problems with the RADIUS configuration, the RADIUS server not running, or some other problem then it is considered as an authentication service unavailable. If the actual authentication fails then it is considered as an authentication failure.

Configuring Authentication Services Unavailable VLAN

When the authentication service is not available for authentication, the supplicant is moved to authentication service unavailable VLAN and given restricted access. To configure the authentication services unavailable VLAN, use the following commands:

```
configure netlogin authentication service-unavailable vlan
unconfigure netlogin authentication service-unavailable vlan
enable netlogin authentication service-unavailable vlan ports
disable netlogin authentication service-unavailable vlan ports
```

If a network login port has `web` enabled, authentication failure VLAN and authentication service unavailable VLAN configuration are not applicable to MAC and dot1x clients connected to that port. For example, if port 1:2 has network login MAC and web authentication enabled and authentication failure VLAN is configured and enabled on it, and if a MAC client connected to that port fails authentication, it is not moved to authentication failure VLAN.

22

CHAPTER

Identity Management

This chapter includes the following sections:

- [Overview on page 807](#)
- [Identity Management Feature Limitations on page 822](#)
- [Configuring Identity Management on page 822](#)
- [Managing the Identity Management Feature on page 831](#)
- [Displaying Identity Management Information on page 832](#)

Overview

The identity management feature allows you to learn more about the users and devices (such as phones and routers) that connect to a switch. In this chapter, users and devices are collectively called *identities*. This feature does the following to support identity management:

- Captures identity information when users and devices connect to and disconnect from the switch.
- Stores captured identity information and identity event data in a local database.
- Generates EMS messages for user and device events.
- Makes collected identity information available for viewing by admin-level users and to management applications such as Ridgeline through XML APIs.
- Uses locally collected identity information to query an LDAP server and collect additional information about connected identities.
- Supports custom configurations called *roles*, which are selected based on identity information collected locally and from an LDAP server.
- Uses roles to enable traffic filtering, counting, and metering on ports (using ACLs and policies) in response to identity events (connections, disconnections, and time-outs).
- Supports the configuration of blacklist to deny all access to an identity and whitelists to permit all access to an identity.
- Supports the configuration of greylist to enable the network administrator to choose usernames whose identity is not required to be maintained. When these usernames are added to greylist, the Identity Management module does not create an identity when these users log on.
- Integrates with UPM to modify the switch configuration in response to discovered identities
- Services users under different domains by allowing different domains to be configured and then adding different LDAP servers for those different domains.

**NOTE**

This chapter discusses identity management features that are managed using the switch CLI. Related features are described in other chapters and in the Ridgeline product documentation. For a description of identity management that ties all the related components together, see the application note titled *Deploying an Identity Aware Network*, which is available from Extreme Networks.

The following sections provide additional information on identity management:

- [Identity Information Capture on page 808](#)
- [Identity Names on page 809](#)
- [Application of ACLs and Policies for Identities on page 810](#)
- [Switch Configuration Changes in Response to Identity Management Events on page 822](#)

Identity Information Capture

The identity management feature collects user and device data whenever users or devices connect to or disconnect from the switch. [Table 94](#) lists the identity management attributes that the identity manager process collects from the listed switch software components.

Table 94: Identity (User/Device) Attributes and Source Software Components

Attribute	NetLogin	LLDP	FDB	IP-Security	Kerberos Snooping
User's MAC address	X	X	X	X	X
Authentication and unauthentication time stamp	X	X	X	X	X
User's port	X	X	X	X	X
User's VLANs	X		X	X	X
User's identity	X	X			X
IPv4 to MAC binding			X	X	X
NetLogin authentication protocol	X				
Authentication failures	X				
Device capabilities ^a		X			
Device model name ^a		X			
Device manufacturer name ^a		X			

a. Identity manager receives these attributes only from LLDP enabled ports when the remote device is configured to send the corresponding TLV.

The software components in [Table 94](#) trigger identity attribute collection when a user or device connects to the switch. All components provide the MAC address, authentication and unauthentication time stamps, and the port to which the identity connected. When multiple components are triggered by a user or device connection, the triggers usually happen at different times. Identity manager responds to all identity event triggers, adding additional information to the identity database each time it becomes available.

To capture all the available attribute information listed in [Table 94](#), enable the following features:

- Network login. For more information, see [Chapter 21, “Network Login.”](#)
- LLDP. For more information, see [Chapter 8, “LLDP.”](#)
- IP security. For more information, see [Chapter 23, “Security.”](#)

By default, the identity management feature collects information from all Kerberos servers using Kerberos snooping. Kerberos authentication or ticketing is used by Microsoft's Active Directory. The Kerberos snooping feature collects identity attributes from Kerberos Version 5 traffic. This feature does not capture information from earlier versions of Kerberos.



NOTE

Extreme Networks recommends that you enable CPU DoS protect in combination with Kerberos snooping to make sure the CPU is not flooded with mirrored Kerberos packets in the event of a DoS attack on Kerberos TCP/UDP ports. If the rate limiting capability is leveraged on capable platforms, it is applied on CPU mirrored packets.

Because an identity entry in the identity manager database can contain information from various software components (listed in [Table 94](#)), when a component other than network login triggers an identity removal, only the attributes supplied by that component are removed from the identity. When network login triggers an identity removal, all attributes for that identity are removed from the identity manager database.

Identity Names

After identity attributes are captured, they can be viewed with show commands on the switch. The identity *ID Name* assigned to each identity depends on the identity attributes collected. For example, if a MAC address detected by FDB is not correlated by at least one other software component, the identity is considered an *unknown identity*, and identity manager creates an identity entry with the name *unknown_<MAC-Address>*, where *MAC-Address* is replaced with the actual MAC address.

When an FDB detected MAC address is correlated by another software component, the identity is considered a *known identity*, and the identity manager names the identity based on the identity attributes. For example, if a user name is collected, the user name becomes the ID name. If a username is not discovered, identity manager creates a name based on the MAC address.

Identity manager can change the ID name when additional attributes are learned, or when the identity status changes between *known* and *unknown*. For example, if LLDP sends an identity removal trigger to the identity manager for an LLDP-based identity, and if a valid FDB entry exists for the removed identity, the identity manager reestablishes the identity as an unknown identity (*unknown_<MAC-Address>*).



NOTE

If FDB triggers the removal of the MAC address for an unknown identity, the identity manager deletes the corresponding unknown identity after a period of time.

Application of ACLs and Policies for Identities

Each time the identity manager detects a new identity or an identity change, it evaluates the identity attributes to determine which role to apply to the identity. A *role* is a switch configuration entity that identifies ACLs to apply to a port in response to an identity presence.

The following sections provide more information port configuration for identities:

- [How Roles Affect Ports on page 810](#)
- [Authenticated and Unauthenticated Roles on page 810](#)
- [Blacklist and Whitelist Roles on page 811](#)
- [Greylist Roles on page 811](#)
- [User-Defined Roles on page 812](#)
- [Role Precedence and Priority on page 816](#)
- [Application of Rules or Policies on page 817](#)

How Roles Affect Ports

A role is a configuration entity to which you can add multiple policy files or dynamic ACL rules. When an identity is matched to a role, any policies or rules attached to that role are applied to the port to which the identity connected. These rules or policies permit or deny traffic, increment traffic counters, or implement traffic meters. When identity manager detects a removal trigger for an identity, all rules or policies associated with the identity are removed from the port on which the identity was detected.

Authenticated and Unauthenticated Roles

The identity management feature supports two default roles—authenticated and unauthenticated. No default rules or policies are configured for these roles, but you can add rules or policies to these roles.

Authenticated identities are known identities that meet the following requirements:

- Are not included in the blacklist or whitelist.
- Do not meet the match criteria for any user-defined roles.
- Cannot meet the match criteria for any user-defined role with LDAP attributes because no LDAP server is available or because LDAP queries are disabled.
- Are detected either through network login (using any of the network login methods) or through Kerberos snooping.

The *unauthenticated* role applies to all identities that do not match any other default or user-defined role. For example, the following identities are placed in the unauthenticated role:

- A device detected by LLDP that has not authenticated through network login and does not match any other default or user-defined role.
- A user who does not successfully log in using Kerberos login and does not match any other default or user-defined role.
- A device discovered through IP ARP or DHCP snooping that does not match any other default or user-defined role.
- Any identity classified as an unknown identity.

**NOTE**

The unauthenticated role is not applied to network login users because those users are either authenticated or denied by network login.

One option for configuring the unauthenticated role policy/rule is to allow DNS, DHCP, and Kerberos traffic, and deny all other traffic. This configuration allows identities to attempt log in, and denies access to identities that do not successfully log in.

Blacklist and Whitelist Roles

Blacklist and whitelist roles are special roles that are evaluated before all the other role types. If an identity is listed in a blacklist, that identity is denied all access to the network without consideration of any other roles to which it might belong. Similarly, if a discovered identity is found in the whitelist, that identity is granted complete network access, and no further role processing occurs for that identity.

You can configure identities in a blacklist or whitelist using any one the following identity attributes:

- MAC address
- IPv4 address
- Username (with or without a domain name)

The type of identity attribute specified in a blacklist or whitelist impacts the locations from which an identity can access a switch. For example, if a MAC address or an IP address is specified in a blacklist, no access is permitted from any user at devices with the specified address. If a username is specified in a whitelist, that user is permitted access from all locations.

When an identity accesses the switch and that identity is in a blacklist or whitelist, the switch installs a specific deny or allow ACL on the port through which the identity attempts access. The installed ACL is an active ACL that explicitly denies or allows traffic from that identity. There is no passive action that takes place if the identity is not listed in the ACL. When the identity is not listed in a blacklist or whitelist, the switch checks for matches to other roles as described in [“Role Precedence and Priority” on page 816](#).

Greylist Roles

Greylist feature enables the network administrator to choose usernames whose identity is not required to be maintained. When these usernames are added to greylist, the Identity Management module does not create an identity when these users log on.

This will be useful in a scenario wherein multiple users login from same device at the same time. For example, actual user has logged into computer after Kerberos authentication. Later, Anti-Virus Agent(AVAgent) software starts within the same computer and does Kerberos authentication.

This will result in losing actual user identity and creating identity for AVAgent. Configuring AVAgent's username in greylist will prevent the above situation and actual user identity along with policies will be retained when AVAgent user logs in.

List Precedence Configuration.

Greylist entries have higher precedence over blacklist and whitelist entries by default. This means that IDM consults with greylist first, upon detection of user, and then decides if the identity needs to be created. If there is no matching greylist entry, IDM proceeds with role identification for the user.

However, greylist precedence is configurable. The following are three possibilities for greylist precedence configuration:

- greylist, blacklist, whitelist
- blacklist, greylist, whitelist
- blacklist, whitelist, greylist

At this time, blacklist always has precedence over whitelist. To change list precedence, disable IDM first. Disabling IDM is required since reverting roles and revoking policies due to greylist entries may increase processing load. When precedence configuration is changed, each entry present in the list with lower precedence (new precedence) is checked with each entry present in all the lists with higher precedence. If any existing entry becomes ineffective, details of those entries are displayed at the CLI prompt.

User-Defined Roles

User-defined roles allow you to create custom roles that can restrict, count, and meter traffic for identities you want to control. CLI commands allow you to do the following:

- Create a user defined role
- Configure identity match criteria that determine which identities use a role
- Add dynamic ACL rules or policies to a role so that those policies are applied to ports to which a matching identity connects
- Assign a priority level to each role to determine which role applies when multiple roles are matched to an identity
- Establish hierarchical roles that can be used to support topologies built around a company organization structure or a geographical layout

When specifying match criteria for a role, you can specify identity attributes collected by identity manager (see “[Identity Information Capture](#)” on page 808) and those collected from an LDAP server. When configured for an LDAP server, identity manager can send a query to the server with locally collected attributes and retrieve additional attributes for the identity, such as an employee department or title. The use of an LDAP server allows you to design roles that serve departments or localities.

The following sections provide additional information on user-defined roles:

- [Identity Attributes on an LDAP Server on page 812](#)
- [Match Criteria for Selecting User-Defined Roles on page 813](#)
- [Role Policy Order on page 814](#)
- [Role Hierarchy on page 814](#)
- [Role Inheritance on page 814](#)
- [Context Based Roles on page 815](#)

Identity Attributes on an LDAP Server. When identity manager is configured to connect to an LDAP server, identity manager can query the server for the identity attributes listed in [Table 95](#).

Table 95: LDAP Attributes for Role Selection

Attribute	Active Directory LDAP Attribute	Attributes Allowed in Identity Manager Match Criteria
City	l	l or location

Table 95: LDAP Attributes for Role Selection

Attribute	Active Directory LDAP Attribute	Attributes Allowed in Identity Manager Match Criteria
State	st	st or state
Country	co	co or country
Employee ID	employeeID	employeeID
Title	title	title
Department	department	department
Company	company	company
Email Address	mail	mail or email

An LDAP query contains one or more of the identity attributes listed in [Table 94](#).

If an LDAP server fails to respond, the next configured LDAP server is contacted. When a server query succeeds, all further LDAP queries are sent to that LDAP server. All LDAP servers should be configured to synchronize the user information available in each of them.

**NOTE**

Identity manager supports a maximum of 8 LDAP servers.

Match Criteria for Selecting User-Defined Roles. When you create a user-defined role, you must define the match criteria that determines which identities will use the role. The match criteria is a group of identity attributes and the attribute values that must match identities to which this role is assigned. For example, the following command creates a role named *US-Engr* that matches employees whose title is *Engineer* and who work in United States:

```
* Switch.23 # create identity-management role US-Engr match-criteria "title contains Engineer; AND country == US;" priority 100
```

The match criteria is a series of attributes, operators, and attribute values, all of which are described in the *ExtremeXOS Command Reference Guide*. Each role can define up to 16 attribute requirements, and there are additional operators such as *not equal*. The match criteria attributes are combined using only the *AND* operator. When multiple roles are matched to an identity, the role with the highest priority (lowest numerical value) applies.

In the example above, identity manager must be configured to query an LDAP server because the identity attributes listed in the match criteria are not discovered locally.

The match criteria for a role establishes the role as one of two types:

- Local user-defined role
- LDAP user-defined role

A *local user-defined role* uses only the following locally-discovered attributes (which are listed in [Table 94](#)) in the match criteria:

- User's MAC address
- MAC OUI
- User's port

- User's identity
- IPv4-to-MAC binding
- Device capabilities
- Device model name
- Device manufacturer name

Because a local user-defined role does not require LDAP provided attributes, the role can be matched to identities when an LDAP server is unavailable, or when LDAP processing is disabled for network login authenticated identities. A local user-defined role can serve as a backup role to an LDAP user-defined role.

An *LDAP user-defined role* uses one or more of the LDAP attributes listed in [Table 95](#) in the match criteria, and it can also use the attributes listed in [Table 94](#). An LDAP user-defined role gives you more flexibility in selecting attributes for the match criteria. However, if no LDAP server is available, and the identity attributes do not match a local user-defined role, one of the two default roles is applied to the identity.

Role Policy Order. Until EXOS 15.1 the policy or dynamic rule associated to the role was in the order of configuration. There is no provision for the user to change the order of the policy or dynamic rule associated with the role. In EXOS 15.2, support was added for changing the order of the policy or dynamic rule associated with the role. You can also change the order of the policy or dynamic rule during the run time, i.e, even if the role is assigned to some identities, the policy or the dynamic rule associated to the role can be changed.

Role Hierarchy. To make it easier to manage users, the role management feature supports hierarchical roles. Hierarchical roles can be defined to reflect different organizational and functional structures. To create a role hierarchy, one or more roles are defined as *child* roles of what becomes a *parent* role. Each role can have a maximum of 8 child roles and only 1 parent role. This feature can support up to 5 levels of parent and child roles.

Role Inheritance. Child roles inherit the policies of the parent role and all roles above the parent in the hierarchy. When an identity is assigned to a role, the policies and rules defined by that role and all higher roles in the hierarchy are applied.

When the parent role is deleted or when the parent-child relationship is deleted, the child role no longer inherits the parent role's policies and the policies are immediately removed from all identities mapped to the child role.

Since the maximum role hierarchy depth allowed is 5 levels, the maximum number of policies and dynamic ACLs that can be applied to a role is 40 (5 role levels x 8 policies/rules per role). [Figure 100](#) shows an example of hierarchical role management.

Match Criteria Inheritance. In Beginning in EXOS 15.2, the child role can inherit the match criteria of the parent role. This means that the match criteria does not need to be duplicated in all levels of hierarchy.

For example, if you have roles called Employee, India employee, and India engineer in a hierarchy, previously the match criteria of the three roles would have been:

```
“company == Extreme”
```

```
“company == Extreme; AND country == India”
```

```
“company == Extreme; AND country == India; AND department = Engineering”
```

This can be simplified into the following since the child role automatically inherits the parent role's match criteria:

"company == Extreme"

"country == India"

"department = Engineering"

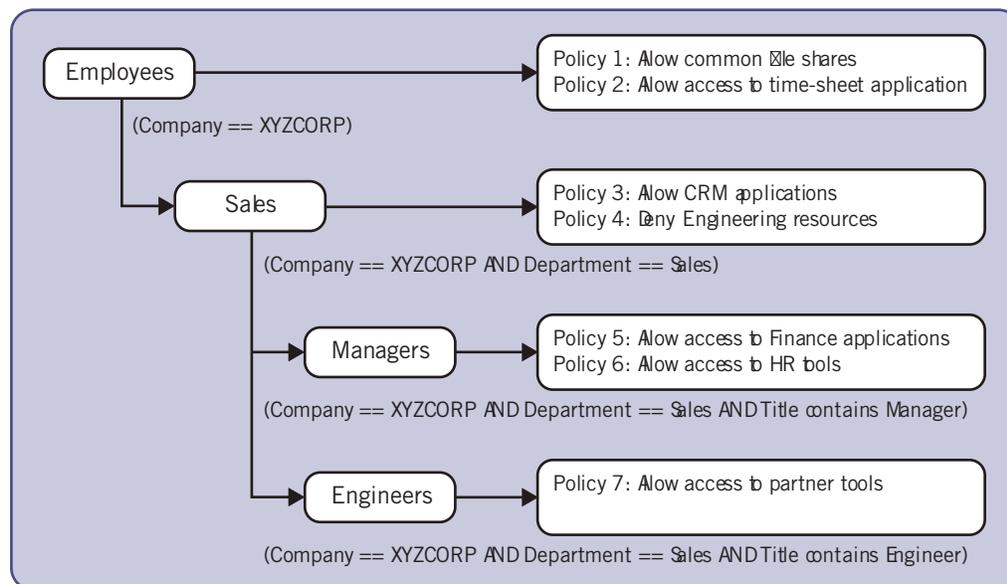
Once this support is enabled, user identity must satisfy not only the role's match criteria, but its parent and ancestors also. This support can be enabled/disabled using CLI or XML. You no longer must repeat the match criteria configured in the parent role in the child roles also.

This feature can only be enabled if all the existing roles have higher priority than their descendants. If this condition is not satisfied, match criteria inheritance will fail. Once this feature is enabled, you cannot configure a child role with lesser priority (higher priority number) than its parent. Enabling this feature changes the order of the roles according to the parent-child relationship. Incoming identities are matched against the child role and then against the parent irrespective of the order of creation.

For example, Role A and Role B have match criteria MC-A and MC-B respectively. Role B is a child role of Role A. When match criteria inheritance is disabled, an identity matches Role B criteria then it is placed under Role B with no further check.

When match criteria inheritance is enabled, the same identity, after satisfying Role B's match criteria, is then checked against Role A's match criteria. Once the identity satisfies child and parent role's match criteria, it is placed under Role B.

Figure 100: Hierarchical Role Management Example



EX_idmgt_0001

Context Based Roles. Context based roles apply additional rules or policies to a port based on context related attributes for an identity. For example, consider a campus environment where a student logs into the network through a PC and also through a smart phone. Suppose that a role named *Student* already exists and applies basic policies for a student. Also suppose that the administrator wants to apply additional policies for students accessing the network through smart phones.

To apply the additional policies, the administrator can create a role called *Student_smartPhone* as a child role of *Student*. The match criteria could include "title == Student; AND mac-oui == 00:1b:63:00:00:00/

FF:FF:FF:00:00:00;", where the MAC address is the address of the smart phone. The additional policies can be added to the new child role. When the student logs in from the PC, the rules applicable to the *Student* role apply. When the student logs in from the smart phone, the policies for the *Student_smartPhone* role apply, in addition to those inherited from the *Student* role.

**NOTE**

A student logging on through an smart phone is placed under *Student_smartPhone* role only if that role has a higher priority (lower numerical value) than the *Student* role.

Role Precedence and Priority

Roles are evaluated for identities in the following sequence:

- 1 The *blacklist* role is searched for the identity. If the identity is in the blacklist, the identity is denied access and role evaluation stops.
- 2 The *whitelist* role is searched for the identity. If the identity is in the whitelist, the identity is allowed access and role evaluation stops.
- 3 A local user-defined role is searched for the identity. If the identity is mapped to a local user-defined role, the identity is allowed access and role evaluation stops for all unknown/LLDP users. For Kerberos and network login users (except those authenticated through the local network login database), a query is sent to an LDAP server with the user attributes. If the Kerberos and network login users (except those authenticated through the local network login database) do not map to any local user-defined role, the identity is placed in authenticated role.

**NOTE**

The LDAP query can be disabled for specific types of network login users, and the LDAP query is disabled for locally authenticated network login identities.

- 4 When the switch receives LDAP attributes for an identity, the software evaluates the user-defined roles. If one or more user-defined roles match the identity attributes, and if those roles have a higher priority (lower numerical value) than the current role applied to the identity, the policies for the current role are removed and the policies for the user-defined role with the highest priority are applied.

**NOTE**

To support a change from the one role to another, the role priority for the new role must be higher than the current role.

- 5 Authenticated identities that cannot be placed in a user-defined role remain assigned to the *authenticated* role.
- 6 The unauthenticated role is applied to all identities that do not match any other roles.

Application of Rules or Policies

When the software makes the final determination of which default or user configured role applies to the identity, the policies and rules configured for that role are applied to the port to which the identity connected. This feature supports up to 8 policies and dynamic ACL rules per role (8 total).

When a dynamic ACL or policy is added to a role, it is immediately installed for all identities mapped to that role. Effective configuration of the dynamic ACLs and policies will ensure that intruders are avoided at the port of entry on the edge switch, thereby reducing noise in the network.



NOTE

The identity management feature supports wide key ACLs, which allow you to create many more match conditions for each ACL. For more information, see [“Wide Key ACLs” on page 668](#).

The dynamic rules or policies which are installed for an identity, as determined by its role, are customized for that identity by inserting the MAC or IP address of the identity as the source address in the ACL rules. In ExtremeXOS Release 12.5, identity manager inserted the IP address of the identity in all the ACL rules to be installed for that identity. Beginning with ExtremeXOS Release 12.6, identity manager can insert either the MAC address or the IP address of the identity in all the ACL rules to be installed for that identity. By default the MAC address of the identity is used to install the ACLs. Every network entity has a MAC address, but not all network devices have an IP address, so Extreme Networks recommends that you use the default configuration to install ACLs for network entities based on the source MAC address.

For additional information on creating ACLs, see [Chapter 18, “ACLs.”](#) For additional information on creating policies, see [Chapter 17, “Policy Manager.”](#)

Role-Based Policy Enforcement

After user information is retrieved from the directory server, it is matched against a configured set of criteria and the user is then assigned to a specific role.

Pre-defined roles contain details of attributes with corresponding values to be used as match-criteria and the policies that need to be applied for that role. The administrator will be provided with a set of CLI commands to map association between role, match-criteria, and policies.

The following is a list of LDAP attributes that can be looked up in the LDAP server:

- Employee/User ID
- Title
- Department
- Company
- City
- State
- Country
- Email ID

Association Between Role and Attribute.

Using CLI, various roles can be created with corresponding match criteria specified in attributes and values.

Association Between Role and Policy.

When a policy is added to a role, the newly added policy will be applied to both existing users mapped to that role as well as new users who get mapped to this role in the future.

Match Criteria Inheritance.

Beginning in EXOS 15.2, a child role can inherit the match criteria of the parent role. The match criteria now does not need to be duplicated in all levels of the hierarchy.

Network Zone Support for Policy Files

Network zone support helps users create a network zone and add multiple IP address and/or MAC addresses, which can then be used in the policy files.

With this new support, you can add a single attribute “source-zone” or “destination-zone” to an entry of a policy file. This entry is then expanded into multiple entries depending upon the number of IP and/or MAC addresses configured in that particular zone. If the zone is added to the policy with the keyword “source-zone”, the attributes that are configured in those particular zones, will be added as either source-address or ethernet-source-address in the policy, whereas, if the network-zone is added as destination-zone, the attributes will be added to the policies as destination-address or ethernet-destination-address.

Once you complete the changes in the zones, and issue a refresh of a specific zone, or all the zones, the policies that have corresponding zones configured as source-zone or destination-zone in their entries will be expanded, and then refreshed in the hardware.

If you configure a policy such as the following to a port or VLAN through applications such as IdMgr, XNV or CLI:

```
Policy: test
entry e1 {
if match all {
    source-zone zone1 ;
}
then {
    permit ;
}
}
```

Upon refreshing the network-zone zone1, the policy will be expanded as below:

```
entry C10:0_10.1.1.1_E1 {
    if match all {
        source-address 10.1.1.1 / 32 ;
    } then {
        permit ;
    }
}

entry C10:0_10.1.1.1_E2 {
```

```

    if match all {
        source-address 10.1.1.1 / 28 ;
    } then {
        permit ;
    }
}

entry C10:0_12.1.1.0_E3 {
    if match all {
        source-address 12.1.1.0 / 24 ;
    } then {
        permit ;
    }
}

```

This converted policy will be the one to be applied in the hardware.



NOTE

When the policy is configured in the network-zone, the zone may or may not have attributes configured with it. In cases where the network-zone does not have any attributes, the policy will be created with entries that do not have the network-zone attribute alone. For example, if you have a policy similar to the following:

```

Policy: test2
entry e1 {
if match all {
    source-zone zone2 ;
    protocol udp ;
}
then {
    permit ;
}
}
entry e2 {
if match all {
    protocol tcp ;
}
then {
    permit ;
}
}

```

and the network-zone “zone02” is created, but not configured with any attributes, the policy would be as follows:

```

entry e2 {
protocol tcp;
}
then {
    permit;
}
}

```

Once the network-zone “zone2” is configured with one or more attributes and refreshed, the policy will be updated accordingly. Here the name of the entries that have source-zone or destination-zone will be

changed. This is because each entry in the original policy that has a source-zone/destination-zone will be converted to a maximum of eight entries in the new policy.

A single policy can have one or more network-zones configured in it, and can also have the same network-zone in multiple entries with different combinations as other attributes are supported in the policy file. Similarly, the same network-zone can be configured to multiple policies. In cases where the policy has multiple network-zones, and only some of those network-zones are refreshed, the entries that correspond to those network-zones will be refreshed alone, and not the entries that correspond to the other network-zones.

Once a refresh of a network zone is issued, all the policies that have the specified network-zone will be modified, and a refresh for each of those policies will be sent to the hardware. The command will succeed only after getting a success return for all the policies that have this particular network-zone. If one of the policy's refresh fails in the hardware, all of the policies that are supposed to refresh will revert to their previous successful state and the command will be rejected.

The configuration or refresh may fail if the attributes in the network zone are not compatible with the attributes in the corresponding entries of the policy. For example, in platforms that do not support wide-key or UDF, a policy entry cannot have layer 2 attributes and layer 4 attributes. In this case, if the entry has "protocol tcp", and a network zone which has an ethernet source address, the configuration will fail in the hardware.



NOTE

In the refresh failed case, the content of the policy and the content of the network-zone may go out of sync, as the policy will be reverted back to the last successful state, whereas the network zone will contain the last configured values. For example, if we have the the network-zone configuration as follows:

```
create access-list network-zone zone1
configure access-list network-zone zone1 add ipaddress 10.1.1.1/32
configure access-list network-zone zone1 add ipaddress 10.1.1.1/28
```

and this is refreshed, and has been successfully installed in the hardware, the policy will look like this:

```
entry C10:0_10.1.1.1_E1 {
  if match all {
    source-address 10.1.1.1 / 32 ;
  } then {
    permit ;
  }
}

entry C10:0_10.1.1.1_E2 {
  if match all {
    source-address 10.1.1.1 / 28 ;
  } then {
    permit ;
  }
}
```

Now, if the user removes 10.1.1.1/28, and adds 10.1.1.1/24 to the network zone as below:

```
configure access-list network-zone zone1 delete ipaddress 10.1.1.1/28
configure access-list network-zone zone1 add ipaddress 12.1.1.0/24
```

and then does a refresh network-zone, and for some reason, the policy refresh fails, the policy and the network-zone will look as below:

```
entry C10:0_10.1.1.1_E1 {
  if match all {
    source-address 10.1.1.1 / 32 ;
  } then {
    permit ;
  }
}

entry C10:0_10.1.1.1_E2 {
  if match all {
    source-address 10.1.1.1 / 28 ;
  } then {
    permit ;
  }
}

create access-list network-zone zone1
configure access-list network-zone zone1 add ipaddress 10.1.1.1 255.255.255.255
configure access-list network-zone zone1 add ipaddress 12.1.1.0 255.255.255.0
```

Role Refresh

Role refresh allows you to enter a CLI command that triggers a reevaluation of role selection for one or all users. A role refresh can also trigger reevaluation of role selection for all users using a specific role.

After role evaluation completes for an identity, the role remains the same as long as the identity is present at the original location and no new high priority role matching this identity's attributes is created. Consider a situation where a Kerberos user is always present at a particular location. The switch detects traffic to and from the user periodically, so the user identity is never aged out. The user's role at this location remains the same as the role determined by identity manager when the user was detected at this location for the first time.

A network administrator might want to refresh a role for the following reasons:

- The user's LDAP attributes have changed. For example, the user's job title is changed from Engineer to Manager or his department is changed from Engineering to Marketing.
- The administrator has created a new role, which is more applicable to the user than his previous role. For example, the user was initially placed under the *Engineer* role because his department was Engineering, and now a new role called *Test Engineer* is a better match that considers both the user's department and title.

For both of the above situations, a role refresh triggers a role evaluation that would not otherwise occur as long as the user remains active at the current location. If the role refresh finds an LDAP user-defined role that matches the identity being refreshed, the identity manager queries the LDAP server to update the attributes provided by the LDAP server.

Switch Configuration Changes in Response to Identity Management Events

You can configure automatic switch configuration changes in response to identity management events. To do this, configure UPM profiles to respond to identity management events as described in [“Event Management System Triggers” on page 333](#).

Identity management events generate corresponding UPM events. The UPM events that are generated include:

- IDENTITY-DETECT
- IDENTITY-UNDETECT
- IDENTITY-ROLE-ASSOCIATE
- IDENTITY-ROLE-DISSOCIATE

For instructions on displaying a complete identity management event list, see [“Event Management System Triggers” on page 333](#). The component name for identity management events is *IdMgr*.

Identity Management Feature Limitations

In the current release, the identity management feature has the following limitations:

- IPv4 support only. IPv6 to MAC bindings are not captured.
- For Kerberos snooping, clients must have a direct Layer 2 connection to the switch; that is, the connection must not cross a Layer 3 boundary. If the connection does cross a Layer 3 boundary, the gateway's MAC address gets associated with the identity.
- Kerberos snooping does not work on fragmented IPv4 packets.
- Kerberos identities are not detected when both server and client ports are added to identity management.
- Kerberos does not have a logout mechanism, so mapped identities are valid for the time period defined by the Kerberos aging timer or the Force aging timer.
- Kerberos snooping applied ACLs can conflict with other ACLs in the system. The identity management feature registers itself in the user space SYSTEM zone; for details, see [“Configuring ACL Priority” on page 673](#).

Configuring Identity Management

The following sections describe configuration options for the identity management feature:

- [Basic Identity Management Feature Configuration on page 823](#)
- [Enabling and Disabling SNMP Traps on page 825](#)
- [Adding and Deleting Entries in the Blacklist and Whitelist on page 825](#)
- [Configuring Kerberos Snooping on page 827](#)
- [Configuring Default and User-Defined Roles on page 828](#)

Basic Identity Management Feature Configuration

The following sections describe basic identity management configuration tasks:

- [Configuring the Maximum Database Size on page 823](#)
- [Selecting the Access-List Source-Address Type on page 823](#)
- [Enabling and Disabling Identity Management on page 824](#)
- [Enabling and Disabling Identity Management on Ports on page 824](#)
- [Adjusting the Aging Time for Stale Entries on page 825](#)
- [Resetting the Identity Management Configuration to the Default Values on page 825](#)



NOTE

When a switch is managed by NMS, it is possible to modify/delete configurations that are created by NMS. After editing via CLI, these changes are not reflected to NMS. Therefore, CLI configurations will be lost when NMS modifies the configuration further, because NMS configuration overrides CLI configuration. The following warning is printed so that users are aware that the CLI change is not permanent:

```
WARNING: An object that was created by Network Management System(NMS) has been modified. The modification will not be reflected to the NMS and will not be preserved if the object is subsequently modified by the NMS.
```

Configuring the Maximum Database Size

To configure the maximum size for the identity management database, use the following command:

```
configure identity-management database memory-size <Kbytes>
```

To set the maximum database size to the default value, use the following command:

```
unconfigure identity-management database memory-size
```

Selecting the Access-List Source-Address Type

The identity management feature can install ACLs for identities based on the source MAC or source IP address. By default the MAC address of the identity is used to install the ACLs. Every network entity has a MAC address, but not all network devices have an IP address, so Extreme Networks recommends that you use the default `mac` selection to install ACLs for network entities based on the source MAC address.

To change the configuration for the access-list source-address type, use the following command:

```
configure identity-management access-list source-address [mac | ip]
```



NOTE

You must disable identity management to change the current access-list source-address type configuration.



NOTE

By default, the identity's MAC address is used for applying the dynamic ACLs and policies. The dynamic ACLs or policies that are associated to roles should not have any source MAC address specified because the identity management feature will dynamically insert the identity's MAC address as the source MAC address.

Similarly, if the ACL source address type is configured as `ip`, the dynamic ACLs or policies that are associated to roles should not have any source IP address specified.

Enabling and Disabling Identity Management

To enable or disable the identity management feature, use the following admin-level commands:

```
enable identity-management
disable identity-management
```



NOTE

When the identity management feature is first enabled, the FDB entries previously learned on identity-management enabled ports are flushed.

Identity manager does not detect and create identities for FDB blackhole and static entries.

Enabling and Disabling Identity Management on Ports

To enable or disable identity management on specific ports, use the following command:

```
configure identity-management {add | delete} ports [<port_list> | all]
```

To return to the default value, which removes all ports from the port list, use the following command:

```
unconfigure identity-management ports
```

Enabling and Disabling SNMP Traps

To enable the transmission of SNMP traps for identity management low memory conditions, use the following command:

```
enable snmp traps identity-management
```

To disable SNMP traps for identity management, use the following command:

```
disable snmp traps identity-management
```

Adjusting the Aging Time for Stale Entries

The stale-entry aging time defines when event entries in the identity management database become stale. To preserve memory, the software periodically uses a cleanup process to remove the stale entries. To adjust the period at which stale database entries are deleted (regardless of the database usage level), use the following command:

```
configure identity-management stale-entry aging-time <seconds>
```



NOTE

For additional information on the stale-entry aging time and how it can be automatically adjusted by the software, see the command description for the above command.

To set the stale-entry aging time to the default value, use the following command:

```
unconfigure identity-management stale-entry aging-time
```

Resetting the Identity Management Configuration to the Default Values

To reset the identity management configuration to the default values, use the following command:

```
unconfigure identity-management
```

Adding and Deleting Entries in the Blacklist and Whitelist

To add or delete entries in the blacklist or whitelist, use the following commands:

```
configure identity-management blacklist add [mac <mac_address> {<macmask>} | ip
<ip_address> {<netmask>} | <ipNetmask>] | user <user_name>]
```

```
configure identity-management whitelist add [mac <mac_address> {<macmask>} | ip
<ip_address> {<netmask>} | <ipNetmask>] | user <user_name>]
```

```
configure identity-management blacklist delete [all | mac <mac_address> {<macmask>} |
ip <ip_address> {<netmask>} | <ipNetmask>] | user <user_name>]
```

```
configure identity-management whitelist delete [all | mac <mac_address> {<macmask>} |
ip <ip_address> {<netmask>} | <ipNetmask>] | user <user_name>]
```

Configuring Entries in Greylist

To add or delete entries in greylist, use the following commands:

```
configure identity-management greylist add user <username>
configure identity-management greylist delete [all | user <username>]
```

To display the entries in greylist, use the following commands:

```
show identity-management greylist
```

Configuring List-Precedence

To configure or reset list-precedence, use the following commands.

```
configure identity-management list-precedence <listname1> <listname2> <listname3>
unconfigure identity-management list-precedence
```

To display the list-precedence configuration, use the following command

```
show identity-management list-precedence
```

To display the entries in the blacklist or whitelist, use the following commands:

```
show identity-management blacklist
```

```
show identity-management whitelist
```

Configuring Kerberos Snooping

Kerberos authentication or ticketing is used by Microsoft's Active Directory, and by various Unix systems (including Linux and MAC OSX). The Kerberos snooping feature in the ExtremeXOS software collects identity information from Kerberos Version 5 traffic. This feature does not capture information from earlier versions of Kerberos.



NOTE

Extreme Networks recommends that you enable CPU DoS protect in combination with this feature to make sure the CPU is not flooded with mirrored Kerberos packets in the event of a DoS attack on Kerberos TCP/UDP ports. If the rate limiting capability is leveraged on capable platforms, it is applied on CPU mirrored packets.

Kerberos snooping is enabled when you enable identity management. The following sections describe how to configure Kerberos snooping on the switch:

- [Configuring a Kerberos Server List on page 827](#)
- [Adjusting the Kerberos Snooping Aging Time on page 827](#)
- [Forcing Kerberos Logout on page 828](#)



NOTE

Kerberos identities are not detected when both server and client ports are added to identity management.

Configuring a Kerberos Server List

By default, the identity management feature collects information from all Kerberos servers. However, this can subject the switch to DoS attacks targeted at Kerberos servers. To reduce the opportunities for DoS attacks, you can configure a Kerberos server list for identity management. When a Kerberos server list exists, identity management collects information only from the servers in the list.

To add a server to the Kerberos server list, use the following command:

```
configure identity-management kerberos snooping add server <ip_address>
```

To delete a server from the Kerberos server list, use the following command:

```
configure identity-management kerberos snooping delete server [<ip_address>|all]
```



NOTE

Identity management supports configuration of up to 20 Kerberos servers.

Adjusting the Kerberos Snooping Aging Time

Kerberos does not provide any service for un-authentication or logout. Kerberos does provide a ticket lifetime, but that value is encrypted and cannot be detected during snooping. To enable the aging and removal of snooped Kerberos entries, this timer defines the maximum age for a snooped entry. When a MAC address with a corresponding Kerberos entry in identity manager is aged out, the Kerberos snooping aging timer starts. If the MAC address becomes active before the Kerberos snooping aging timer expires, the timer is reset and the Kerberos entry remains active. If the MAC address is inactive when the Kerberos snooping aging timer expires, the Kerberos entry is removed.

To configure the Kerberos snooping aging time, use the following command:

```
configure identity-management kerberos snooping aging time <minutes>
```

To reset the Kerberos snooping aging time to the default value, use the following command:

```
unconfigure identity-management kerberos snooping {aging time}
```

**NOTE**

The default value for this command is *none*, which means that an identity discovered through Kerberos snooping is removed immediately on the aging out of the identity MAC address by the FDB manager.

Forcing Kerberos Logout

To force the removal of all identities discovered through Kerberos snooping, use the following command:

```
configure identity-management kerberos snooping force-aging time [none | <minutes>]
```

Configuring Default and User-Defined Roles

- [Creating and Deleting User-Defined Roles on page 828](#)
- [Configuring Rules or Policies for Default and User-Defined Roles on page 829](#)
- [Configuring LDAP Server Access on page 829](#)
- [Changing the Role Priority on page 830](#)

Creating and Deleting User-Defined Roles

To create or delete a role, use the following commands:

```
create identity-management role <role_name> match-criteria <match_criteria> {priority <pri_value>}
```

```
delete identity-management role {<role-name> | all}
```

To create or delete a child role, use the following commands:

```
configure identity-management role <role_name> add child-role <child_role>
```

```
configure identity-management role <role_name> delete child-role [<child_role> | all]
```

Configuring Rules or Policies for Default and User-Defined Roles

The default *authenticated* and *unauthenticated* roles contain no rules or policies. When you first create a user-defined role, it also contains no rules or policies. To add or delete a rule or policy from a role, use the following commands:

```
configure identity-management role <role_name> [add dynamic-rule <rule_name> { first | last | { [before | after] <ref_rule_name>}}]
```

```
configure identity-management role <role_name> add policy <policy-name> {first | last {[before | after] <ref_policy_name>}}
```

```
configure identity-management role <role_name> delete dynamic-rule [<rule_name> | all]
```

```
configure identity-management role <role_name> delete policy [<policy-name> | all]
```

Configuring LDAP Server Access

To add or remove LDAP server connections for retrieving identity attributes, use the following commands:

```
configure {identity-management} ldap {domain <domain_name>} add server [<host_ipaddr> | <host_name>] {<server_port>} {client-ip <client_ipaddr>} {vr <vr_name>} {encrypted sasl digest-md5}
```

To configure LDAP client credentials for accessing an LDAP server, use the following command:

```
configure {identity-management} ldap {domain [<domain_name>|all]} bind-user [<user_name> {encrypted} <password> | anonymous]
```

To specify a base domain name to be added to usernames in LDAP queries, use the following command:

```
configure {identity-management} ldap {domain [<domain_name>|all]} base-dn [<base_dn> | none | default]
```

To enable or disable LDAP queries for specific network login types, use the following command:

```
configure {identity-management} ldap { domain [ <domain_name> | all ] } [enable|disable] netlogin [dot1x | mac | web-based]
```

Support for Multiple Windows Domains

Some organizations are large enough to use multiple Windows domains (sub-domains) in their networks. Each Windows domain can have its own LDAP server.

In previous releases, identity manager supported up to eight LDAP servers which are assumed to be replicas on the same domain (default base-dn). In EXOS 15.2 identity manager supports multiple Windows domains.

LDAP Servers in Different Domains.

In EXOS 15.2 identity manager can service users under different domains. You can configure different domains and add different LDAP servers for these different domains. When adding an LDAP server to identity manager, you can specify the domain under which the server is to be added.

- You can configure a base-dn and a bind user for each domain.
- Base-dn is assumed to be the same as the domain name unless explicitly configured otherwise. (Base-dn is the LDAP directory under which the users are to be searched.)
- For users upgrading from older configurations, the base-dn configured on an older EXOS version now becomes the default domain name. This can be changed later if required.
- For users upgrading from older configurations, the LDAP servers configured on older EXOS versions are now servers under the default domain.
- You can now add up to eight LDAP servers to each of the user-configured domains.

LDAP Connections.

Identity manager tries to maintain LDAP connections with one of the servers in each of the configured domains. LDAP queries for users logging on to those domains will be sent to the respective servers or to a server on the default domain if the user does not fall under any configured domain. The LDAP server might choose to close the connection after a timeout.

LDAP Process.

Identity manager tries to bind to one of the configured LDAP servers in each of the user configured domains.

When a new user is detected, the user's domain is used to determine the LDAP server to be contacted for the user's details.

If there is a match, the LDAP server corresponding to that domain is chosen and the LDAP search request for the user attributes is sent to that LDAP server.

If the domain does not match any of the configured domains, LDAP query is sent to a server in the default domain.

Changing the Role Priority

The role priority is defined when a role is created. To change the priority for a role, use the following commands:

```
configure identity-management role <role_name> priority <pri_value>
```

Managing the Identity Management Feature

The following sections describe management tasks for the identity management feature:

- [Clearing the Identity Management Counters on page 831](#)
- [Refreshing the Role Selection for Users on page 831](#)

Clearing the Identity Management Counters

To clear the statistics counters for the identity management feature, enter either of the following commands:

```
clear counters
clear counters identity-management
```

Refreshing the Role Selection for Users

To refresh role evaluation for a specified user, for all users, or for all users currently using the specified role, enter either of the following command:

```
refresh identity-management role user [<user_name> {domain <domain_name>} | all {role <role_name>}]
```

Enabling/Disabling Snooping Identities

The identity management feature makes the edge of the network more intelligent by providing access to the devices/users in the network. The identity manager detects the identities through the following protocols:

- FDB
- IPARP
- IPsec DHCP Snooping
- LLDP
- Netlogin
- Kerberos

By default, identity management detects identities through all of the above mentioned protocols. There is no way for the administrator to disable the detection of the identities that are triggered through the above protocols.

This feature now provides the administrator an option to enable/disable the detection of the identities that are triggered through any of the above protocols. The administrator can now control the identity detection through any of the protocol triggers at port level. This configuration can be applied to identity management-enabled ports only. An error is received if this configuration is applied to identity management-disabled ports.

As part of this feature, the limitation of FDB entries getting cleared on enabling identity management on a port is removed. The identity management module will retrieve the FDB entries learned on the identity management-enabled ports and create the identity accordingly.

**NOTE**

All types of Netlogin identity will not be detected if the netlogin detection is disabled.

**NOTE**

Enabling Kerberos identity detection does not create identities for previously authenticated clients.

Displaying Identity Management Information

The following sections describe how to display information for the identity management feature:

- [Displaying Database Entries on page 832](#)
- [Displaying Configuration Information on page 832](#)
- [Displaying Statistics on page 832](#)

Displaying Database Entries

To display the entries in the identity management database, you must log in as an admin-level user and enter the following command:

```
show identity-management entries {user <id_name>} {domain <domain>} {ports  
<port_list>} {mac <mac_address>} {vlan <vlan_name>} {ipaddress <ip_address>} {detail}
```

Displaying Configuration Information

Use the following command to display the current configuration of the identity management feature:

```
show identity-management
```

To display role configuration information, use the following command:

```
show identity-management role {<role-name>} {detail}
```

Displaying Statistics

To display operating statistics for the identity management feature, enter the following command:

```
show identity-management statistics
```

To clear the statistics counters for the identity management feature, enter either of the following commands:

```
clear counters  
clear counters identity-management
```

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CHAPTER

Security

This chapter includes the following sections:

- [Overview on page 833](#)
- [Safe Defaults Mode on page 835](#)
- [MAC Security on page 835](#)
- [DHCP Server on page 844](#)
- [IP Security on page 845](#)
- [Denial of Service Protection on page 860](#)
- [Authenticating Management Sessions Through the Local Database on page 863](#)
- [Authenticating Management Sessions Through a TACACS+ Server on page 863](#)
- [Authenticating Management Sessions Through a RADIUS Server on page 869](#)
- [Authenticating Network Login Users Through a RADIUS Server on page 871](#)
- [Configuring the RADIUS Client on page 872](#)
- [RADIUS Server Configuration Guidelines on page 876](#)
- [Configuring a Windows XP Supplicant for 802.1x Authentication on page 899](#)
- [Hypertext Transfer Protocol on page 899](#)
- [Secure Shell 2 on page 900](#)
- [Secure Socket Layer on page 908](#)

Overview

Security is a term that covers several different aspects of network use and operation. One general type of security is control of the devices or users that can access the network. Ways of doing this include authenticating the user at the point of logging in. You can also control access by defining limits on certain types of traffic. Another general type of security operates to protect the operation of the switch itself. Security measures in this category include routing policies that can limit the visibility of parts of the network or denial of service protection that prevents the CPU from being overloaded. Finally, management functions for the switch can be protected from unauthorized use. This type of protection uses various types of user authentication.

ExtremeXOS has enhanced security features designed to protect, rapidly detect, and correct anomalies in your network. Extreme Networks products incorporate a number of features designed to enhance the

security of your network while resolving issues with minimal network disruption. No one feature can ensure security, but by using a number of features in concert, you can substantially improve the security of your network.

The following list provides a brief overview of some of the available security features:

- **Access Control Lists**—Access Control Lists (ACLs) are policy files used by the ACL application to perform packet filtering and forwarding decisions on incoming traffic and packets. Each packet arriving on an ingress port is compared to the ACL applied to that port and is either permitted or denied.

For more information about using ACLs to control and limit network access, see [Chapter 18, “ACLs.”](#)

- **CLEAR-Flow**—CLEAR-Flow is a security rules engine available only on BlackDiamond 8000 a-, c-, e-, xl-, and xm-series modules, and Summit X250e, X440, X450a, X450e, X460, X480, X650, and X670 series switches in a non-stack configuration. CLEAR-Flow inspects Layer 2 and Layer 3 packets, isolates suspicious traffic, and enforces policy-based mitigation actions. Policy-based mitigation actions include the switch taking an immediate, predetermined action or sending a copy of the traffic off-switch for analysis. Working together, CLEAR-Flow and Sentiariant™ provide a rapid response to network threats. For off-switch analysis, CLEAR-Flow sends the suspicious traffic to Sentiariant and Sentiariant stops the threats.

For more information about CLEAR-Flow, see [Chapter 24, “CLEAR-Flow.”](#) For more information about Sentiariant, contact your Extreme Networks representative.

- **Denial of Service Protection**—Denial of Service (DoS) protection is a dynamic response mechanism used by the switch to prevent critical network or computing resources from being overwhelmed and rendered inoperative. In essence, DoS protection protects the switch, CPU, and memory from attacks and attempts to characterize the attack (or problem) and filter out the offending traffic so that other functions can continue. If the switch determines it is under attack, the switch reviews the packets in the input buffer and assembles ACLs that automatically stop the offending packets from reaching the CPU. For increased security, you can turn on DoS protection and establish CLEAR-Flow rules at the same time.

For more information about DoS attacks and DoS protection, see [“Denial of Service Protection” on page 860](#). For more information about CLEAR-Flow, see [Chapter 24, “CLEAR-Flow.”](#)

- **Network Login**—Network login controls the admission of user packets and access rights thereby preventing unauthorized access to the network. Network login is controlled on a per port basis. When network login is enabled on a port in a VLAN, that port does not forward any packets until authentication takes place. Network login is capable of three types of authentication: web-based, MAC-based, and 802.1x.

For more information about network login, see [Chapter 21, “Network Login.”](#)

- **Policy Files**—Policy files are text files that contain a series of rule entries describing match conditions and actions to take. Policy files are used by both routing protocol applications (routing policies) and the ACL application (ACLs).

For more information about policy files, see [Chapter 17, “Policy Manager.”](#)

- **Routing Policies**—Routing policies are policy files used by routing protocol applications to control the advertisement, reception, and use of routing information by the switch. By using policies, a set of routes can be selectively permitted or denied based on their attributes for advertisements in the routing domain. Routing policies can be used to “hide” entire networks or to trust only specific sources for routes or ranges of routes.

For more information about using routing policies to control and limit network access, see [Chapter 19, “Routing Policies.”](#)

- **sFlow**—sFlow is a technology designed to monitor network traffic by using a statistical sampling of packets received on each port. sFlow also uses IP headers to gather information about the network.

By gathering statistics about the network, sFlow becomes an early warning system notifying you when there is a spike in traffic activity. Upon analysis, common response mechanisms include applying an ACL, changing Quality of Service (QoS) parameters, or modifying VLAN settings.

For more information about sFlow, see the section “Using sFlow” in Chapter 11, “Status Monitoring and Statistics.”

Safe Defaults Mode

When you set up your switch for the first time, you must connect to the console port to access the switch. After logging in to the switch, you enter safe defaults mode. Although SNMP, Telnet, and switch ports are enabled by default, the script prompts you to confirm those settings. By answering `N` (`No`) to each question, you keep the default settings.

```
Would you like to disable Telnet? [y/N]: No
Would you like to disable SNMP [y/N]: No
Would you like unconfigured ports to be turned off by default [y/N]: No
Would you like to change the failsafe account username and password now? [y/N]: No
Would you like to permit failsafe account access via the management port? [y/N]: No
```

In addition, if you keep the default settings for SNMP and Telnet, the switch returns the following interactive script:

```
Since you have chosen less secure management methods, please remember to increase the
security of your network by taking the following actions:
* change your admin password
* change your failsafe account username and password
* change your SNMP public and private strings
* consider using SNMPv3 to secure network management traffic
```

For more detailed information about safe defaults mode, see “Safe Defaults Setup Method” on page 51.

MAC Security

The switch maintains a database of all media access control (MAC) addresses received on all of its ports. The switch uses the information in this database to decide whether a frame should be forwarded or filtered. MAC security (formerly known as MAC address security) allows you to control the way the Forwarding Database (FDB) is learned and populated. For more information about the FDB, see Chapter 14, “FDB.”

MAC security includes several types of control. You can:

- Limit the number of dynamically-learned MAC addresses allowed per virtual port. For more information, see “Limiting Dynamic MAC Addresses” on page 836.
- “Lock” the FDB entries for a virtual port, so that the current entries will not change, and no additional addresses can be learned on the port. For information, see “MAC Address Lockdown” on page 838.



NOTE

You can either limit dynamic MAC FDB entries or lockdown the current MAC FDB entries, but not both.

- Set a timer on the learned addresses that limits the length of time the learned addresses will be maintained if the devices are disconnected or become inactive. For more information, see [“MAC Address Lockdown with Timeout” on page 839](#).
- Use ACLs to prioritize or stop packet flows based on the source MAC address of the ingress virtual LAN (VLAN) or the destination MAC address of the egress VLAN. For more information about ACL policies, see [Chapter 18, “ACLs.”](#)
- Enhance security, depending on your network configuration, by disabling Layer 2 flooding. For more information about enabling and disabling Layer 2 flooding, see the section, [“Managing Egress Flooding” in Chapter 14, “FDB.”](#)

Limiting Dynamic MAC Addresses

You can set a predefined limit on the number of dynamic MAC addresses that can participate in the network. After the FDB reaches the MAC limit, all new source MAC addresses are blackholed at both the ingress and egress points. These dynamic blackhole entries prevent the MAC addresses from learning and responding to Internet Control Message Protocol (ICMP) and address resolution protocol (ARP) packets.



NOTE

Blackhole FDB entries added due to MAC security violations on BlackDiamond 8800 series switches, SummitStack, and Summit family switches are removed after each FDB aging period regardless of whether the MAC addresses in question are still sending traffic. If the MAC addresses are still sending traffic, the blackhole entries will be re-added after they have been deleted.

Configuring Limit Learning

To limit the number of dynamic MAC addresses that can participate in the network, use the `limit-learning` option in following command:

```
configure ports <portlist> vlan <vlan_name> [limit-learning <number> {action  
[blackhole | stop-learning]} | lock-learning | unlimited-learning | unlock-learning]
```

This command specifies the number of dynamically-learned MAC entries allowed for these ports in this VLAN. The range is 0 to 500,000 addresses.

When the learned limit is reached, all new source MAC addresses are blackholed at the ingress and egress points. This prevents these MAC addresses from learning and responding to ICMP and ARP packets.

Dynamically learned entries still get aged and can be cleared. If entries are cleared or aged out after the learning limit has been reached, new entries will then be able to be learned until the limit is reached again.

Permanent static and permanent dynamic entries can still be added and deleted using the `create fdbentry` and `disable flooding ports` commands. These override any dynamically learned entries.

For ports that have a learning limit in place, the following traffic still flows to the port:

- Packets destined for permanent MAC addresses and other non-blackholed MAC addresses
- Broadcast traffic
- EDP traffic

Traffic from the permanent MAC and any other non-blackholed MAC addresses still flows from the virtual port.

To remove the learning limit, use the `unlimited-learning` option in the following command:

```
configure ports <portlist> vlan <vlan_name> [limit-learning <number> {action
[blackhole | stop-learning]} | lock-learning | unlimited-learning | unlock-learning]
```

The MAC limit-learning feature includes a `stop-learning` argument that protects the switch from exhausting FDB resources with blackhole entries. When `limit-learning` is configured with `stop-learning`, the switch is protected from exhausting FDB resources by not creating blackhole entries. Any additional learning and forwarding is prevented, but packet forwarding is not impacted for existing FDB entries.

On the BlackDiamond 8800 series switches and the Summit X440, X450a, X450e, X460, X480, X650, and X670 series switches, the VLANs in a port are impacted when the configured learning limit is reached.

Displaying Limit Learning Information

To verify the configuration, use the following commands:

```
show vlan <vlan name> security
```

This command displays the MAC security information for the specified VLAN.

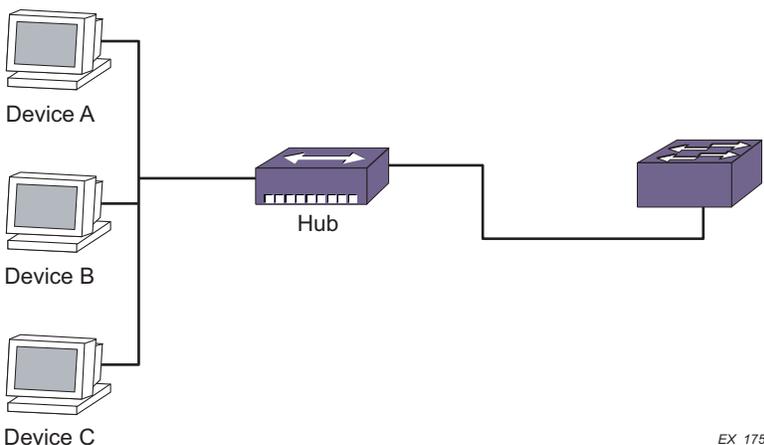
```
show ports {mgmt | <portlist>} info {detail}
```

This command displays detailed information, including MAC security information, for the specified port.

Example of Limit Learning

In [Figure 101](#), three devices are connected through a hub to a single port on the Extreme Networks device. If a learning limit of 3 is set for that port, and you connect a fourth device to the same port, the switch does not learn the MAC address of the new device; rather, the switch blackholes the address.

Figure 101: Switch Configured for Limit Learning

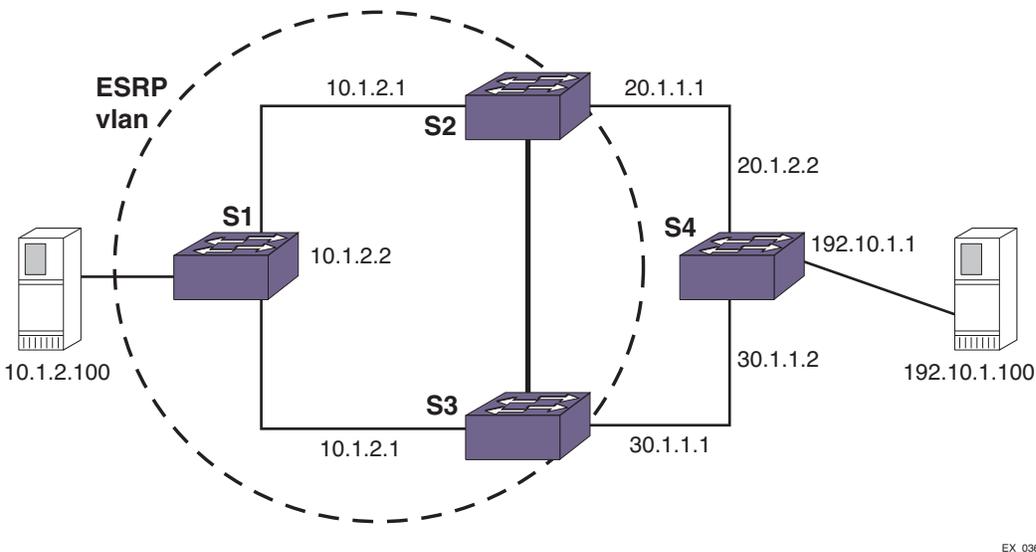


Limiting MAC Addresses with ESRP Enabled

If you configure a MAC address limit on VLANs that participate in an Extreme Standby Router Protocol (ESRP) domain, you should add an additional back-to-back link (that has no MAC address limit on these ports) between the ESRP-enabled switches. Doing so prevents ESRP protocol data units (PDUs) from being dropped due to MAC address limit settings.

Figure 102 is an example of configuring a MAC address limit on a VLAN participating in an ESRP domain.

Figure 102: MAC Address Limits and VLANs Participating in ESRP



In Figure 102, S2 and S3 are ESRP-enabled switches, while S1 is an ESRP-aware (regular Layer 2) switch. Configuring a MAC address limit on all S1 ports might prevent ESRP communication between S2 and S3. To resolve this, you should add a back-to-back link between S2 and S3. This link is not needed if MAC address limiting is configured only on S2 and S3, but not on S1.

MAC Address Lockdown

In contrast to limiting learning on virtual ports, you can lockdown the existing dynamic FDB entries and prevent any additional learning using the `lock-learning` option from the following command:

```
configure ports <portlist> vlan <vlan_name> [limit-learning <number> {action
[blackhole | stop-learning]} | lock-learning | unlimited-learning | unlock-learning]
```

This command causes all dynamic FDB entries associated with the specified VLAN and ports to be converted to locked static entries. It also sets the learning limit to 0, so that no new entries can be learned. All new source MAC addresses are blackholed.



NOTE

Blackhole FDB entries added due to MAC security violations on BlackDiamond 8800 series switches, SummitStack, and Summit family switches are removed after each FDB aging period regardless of whether the MAC addresses in question are still sending traffic. If the MAC addresses are still sending traffic, the blackhole entries will be re-added after they have been deleted.

Locked entries do not get aged, but can be deleted like a regular permanent entry.

For ports that have lock-down in effect, the following traffic still flows to the port:

- Packets destined for the permanent MAC and other non-blackholed MAC addresses
- Broadcast traffic
- EDP traffic

Traffic from the permanent MAC still flows from the virtual port.

To remove MAC address lockdown, use the `unlock-learning` option from the following command:

```
configure ports <portlist> vlan <vlan_name> [limit-learning <number> {action  
[blackhole | stop-learning]} | lock-learning | unlimited-learning | unlock-learning]
```

When you remove the lockdown using the `unlock-learning` option, the learning-limit is reset to unlimited, and all associated entries in the FDB are flushed.

To display the locked entries on the switch, use the following command:

```
show fdb
```

Locked MAC address entries have the “1” flag.

MAC Address Lockdown with Timeout

The MAC address lockdown with timeout feature provides a timer for aging out MAC addresses on a per port basis and overrides the FDB aging time. That is, when this feature is enabled on a port, MAC addresses learned on that port age out based on the MAC lockdown timeout corresponding to the port, not based on the FDB aging time. By default, the MAC address lockdown timer is disabled.

When this feature is enabled on a port, MAC addresses learned on that port remain locked for the MAC lockdown timeout duration corresponding to the port, even when the port goes down. As a result, when a device is directly connected to the switch and then disconnected, the MAC address corresponding to the device will be locked up for the MAC lockdown timeout duration corresponding to that port. If the same device reconnects to the port before the MAC lockdown timer expires and sends traffic, the stored MAC address becomes active and the MAC lockdown timer is restarted. If the device is not reconnected for the MAC lockdown timeout duration, the MAC entry is removed.

MAC lockdown timeout entries are dynamically learned by the switch, which means these entries are not saved or restored during a switch reboot. If the switch reboots, the local MAC entry table is empty, and the switch needs to relearn the MAC addresses.

MAC address lockdown with timeout is configured by individual ports. The lockdown timer and address learning limits are configured separately for a port.



NOTE

You cannot enable the lockdown timeout feature on a port that already has MAC address lockdown enabled. For more information about MAC address lockdown, see [“MAC Address Lockdown” on page 838](#).

MAC address learning limits and the lockdown timer work together in the following ways:

- When the learning limit has been reached on a port, a new device attempting to connect to the port has its MAC address blackholed.

- As long as the timer is still running for a MAC entry, a new device cannot connect in place of the device that entry represents. That is, if a device has disconnected from a port, a new device cannot replace it until the lockdown timer for the first device has expired. This condition is true if the limit on the port is set to 1 or if the limit (greater than 1) on the port has been reached.
- If a learning limit is already configured on a port when you enable the lockdown timeout feature, the configured limit will continue to apply. Existing blackholed entries are therefore not affected. If you enable this feature on a port with no configured learning limit, the default maximum learning limit (unlimited learning) is used.

This section describes the following topics:

- [Understanding the Lockdown Timer on page 840](#)
- [Examples of Active and Inactive Devices on page 840](#)
- [Examples of Disconnecting and Reconnecting Devices on page 841](#)
- [Example of Port Movement on page 842](#)
- [Configuring MAC Address Lockdown with Timeout on page 843](#)
- [Enabling and Disabling MAC Address Lockdown with Timeout on page 843](#)
- [Displaying MAC Address Lockdown Information on page 843](#)

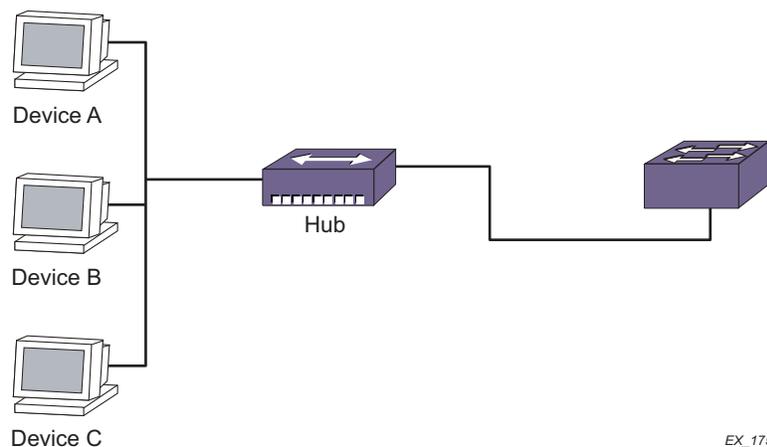
Understanding the Lockdown Timer

The lockdown timer works in the following ways:

- When you enable this feature on a port, existing MAC entries for the port begin aging out based on the configured MAC lockdown timer value.
- If you move a device from one port to another, its MAC address entry is updated with the new port information, including the lockdown timer value configured for that port.
- If this feature is enabled on a port and you decrease the lockdown timer value for that port, all of the MAC FDB entries for that port will time out and be removed at the next polling interval.
- When you disable the lockdown timer on a port, existing MAC address entries for the port will time out based on the FDB aging period.

Examples of Active and Inactive Devices

[Figure 103](#) shows three devices (A, B, and C) connected through a hub to an Extreme Networks device with MAC lockdown timeout configured on the ports. When each device starts sending traffic, the source MAC address of the device is learned and FDB entries are created. The MAC lockdown timer is set at 100 seconds.

Figure 103: Devices Using MAC Address Lockdown

Device Inactivity for Less than the MAC Lockdown Timer. As long as a device continues to send traffic, the MAC entry for that device is refreshed, and the MAC lockdown timer corresponding to the MAC entry is refreshed. Therefore, as long as the device is active, the timer does not expire. The traffic can be continuous or can occur in bursts within the MAC lockdown timeout duration for the port.

In this example, Device A starts sending traffic. When the MAC address of Device A is learned and added to the FDB, the MAC lockdown timer is started for this entry.

Device A stops sending traffic and resumes sending traffic after 50 seconds have elapsed. At this point the MAC entry for Device A is refreshed and the MAC lockdown timer is restarted.

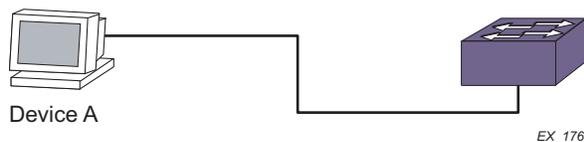
Device Inactivity for Longer than the MAC Lockdown Timer. When a device stops sending traffic and does not resume within the MAC lockdown timer interval for the port, the MAC lockdown timer expires, and the MAC entry is removed from the FDB.

In this example, Devices A, B, and C start sending traffic. As each MAC address is learned, the MAC lockdown timer is started for each entry.

Device A stops sending traffic; Devices B and C continue sending traffic. After 100 seconds, the MAC lockdown timer for the Device A entry is removed from the FDB. Because Devices B and C have continued to send traffic, their MAC entries continue to be refreshed and their MAC lockdown timers continue to be restarted.

Examples of Disconnecting and Reconnecting Devices

Figure 104 shows Device A connected to an Extreme Networks device with MAC lockdown timeout configured for the ports. When Device A starts sending traffic, the source MAC address is learned on the port, the FDB entry is created, and the MAC lockdown timer is started for the entry. The MAC lockdown timer is set at 3,000 seconds.

Figure 104: Single Device with MAC Lockdown Timeout

Disconnecting a Device. In this example, Device A is disconnected from the port, triggering a port-down action. The MAC entry for Device A is removed from the hardware FDB; however, the MAC entry for the device is maintained in the software. The MAC lockdown timer for this entry starts when the port goes down.

After 3,000 seconds, the MAC entry for Device A is removed from the software.

Disconnecting and Reconnecting a Device. When Device A is disconnected from the port, the resulting port-down action causes the MAC entry for Device A to be removed from the hardware FDB. The MAC entry in software is maintained, and the MAC lockdown timer is started for the port.

After only 1,000 seconds have elapsed, Device A is reconnected to the same port and starts sending traffic. A MAC entry is created in the hardware FDB, and the MAC lockdown timer is restarted for the MAC entry in the software.

If Device A is reconnected but does not send any traffic for 3,000 seconds, no MAC entry is created in the hardware FDB, and the MAC lockdown timer will expire after reaching 3,000 seconds.

Disconnecting and Reconnecting Devices with MAC Limit Learning. In this example, a MAC learning limit of 1 has also been configured on the ports in addition to the MAC lockdown timer of 3000 seconds.

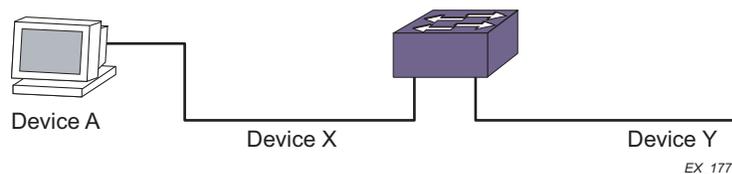
When Device A is disconnected, the resulting port-down action removes the MAC entry for Device A from the hardware FDB. The MAC entry for Device A is maintained in the software, and the MAC lockdown timer for this entry is restarted when the port goes down.

After 1000 seconds, a different device is connected to the same port and starts sending traffic. Because the MAC learning limit is set to 1 and the MAC lockdown timer is still running, the MAC address of the new device is not learned. Instead, the new MAC address is blackholed in the hardware.

When the MAC lockdown timer for Device A expires, its MAC entry is removed from the software. If the new device is still connected to the same port and sends traffic, the MAC address for the new device is learned and added to the FDB. The MAC lockdown timer for the new device is started, and the blackhole entry that was created for this device is deleted.

Example of Port Movement

Figure 105 shows Device A connected to port X. Port X has a MAC lockdown timer setting of 100 seconds, and port Y has a MAC lockdown timer setting of 200 seconds.

Figure 105: Port Movement with MAC Lockdown Timeout

Device A starts sending traffic on port X. The MAC address for Device A is learned and added to the FDB, and the MAC lockdown timer (100 seconds) is started for this entry.

After 50 seconds, Device A is disconnected from port X and connected to port Y where it begins sending traffic. When Device A starts sending traffic on port Y, the existing MAC entry for Device A is refreshed, and port X in the entry is replaced with port Y. At the same time, the MAC lockdown timer for the entry is restarted for a duration of 200 seconds (the configured MAC lockdown timer setting for port Y).

Configuring MAC Address Lockdown with Timeout

To configure the MAC lockdown timeout value on one or more specified ports, or on all ports, use the following command:

```
configure mac-lockdown-timeout ports [all | <port_list>] aging-time <seconds>
```

Enabling and Disabling MAC Address Lockdown with Timeout

To enable the MAC lockdown timeout feature on one or more specified ports, or on all ports, use the following command:

```
enable mac-lockdown-timeout ports [all | <port_list>]
```

To disable the MAC lockdown timeout feature on one or more specified ports, or on all ports, use the following command:

```
disable mac-lockdown-timeout ports [all | <port_list>]
```

Displaying MAC Address Lockdown Information

To display configuration information about the MAC lockdown timeout feature, use the following command:

```
show mac-lockdown-timeout ports [all | <port_list>]
```

Output from this command includes the configured timeout value and whether the feature is enabled or disabled.

To display the MAC entries learned on one or more ports, or on all ports, use the following command:

```
show mac-lockdown-timeout fdb ports [all | <port_list>]
```

Output from this command also lists the aging time of the port.

DHCP Server

ExtremeXOS has Dynamic Host Configuration Protocol (DHCP) support. In simple terms, a DHCP server dynamically manages and allocates IP addresses to clients. When a client accesses the network, the DHCP server provides an IP address to that client. The client is not required to receive the same IP address each time it accesses the network. A DHCP server with limited configuration capabilities is included in the switch to provide IP addresses to clients.

This section describes the following topics:

- [Enabling and Disabling DHCP on page 844](#)
- [Configuring the DHCP Server on page 844](#)
- [Displaying DHCP Information on page 845](#)

Enabling and Disabling DHCP

DHCP is enabled on a per port, per VLAN basis. To enable or disable DHCP on a port in a VLAN, use one of the following commands:

```
enable dhcp ports <portlist> vlan <vlan_name>
disable dhcp ports <portlist> vlan <vlan_name>
```

Configuring the DHCP Server

The following commands allow you to configure the DHCP server included in the switch. The parameters available to configure include the IP address range, IP address lease, and multiple DHCP options.

Until EXOS 15.1, the DHCP server had a limited set of known DHCP options it could send out on request, i.e., Default Gateway, DNS, and WINS server(s). General option support has been added in EXOS 15.2. This allows you to add support for any option needed, with no EXOS code changes. The three options mentioned above can also be overwritten to support a larger number of servers, if needed. This feature allows the switch administrator to add an option based on DHCP option code value, and support various ways of setting the value.

To configure the range of IP addresses assigned by the DHCP server, use the following command:

```
configure vlan <vlan_name> dhcp-address-range <ipaddress1> - <ipaddress2>
```

To remove the address range information, use the following command:

```
unconfigure vlan <vlan_name> dhcp-address-range
```

To set how long the IP address lease assigned by the server exists, use the following command:

```
configure vlan <vlan_name> dhcp-lease-timer <lease-timer>
```

**NOTE**

The ExtremeXOS DHCP server allows the configuration of a DHCP lease timer value greater than 2 seconds only. The timer value range is 3–4294967295.

**NOTE**

If the DHCP lease timer is not configured, the ExtremeXOS DHCP server offers an IP address with the default lease time of 7200 seconds.

To set the default gateway, Domain Name Servers (DNS) addresses, or Windows Internet Naming Service (WINS) server, use the following command:

```
configure {vlan} <vlan_name> dhcp-options [default-gateway | dns-server {primary | secondary} | wins-server] <ipaddress>
```

To remove the default gateway, DNS server addresses, and WINS server information for a particular VLAN, use the following command:

```
unconfigure {vlan} <vlan_name> dhcp-options {[ default-gateway | dns-server {primary | secondary} | wins-server]}
```

To remove all the DHCP information for a particular VLAN, use the following command:

```
unconfigure vlan <vlan_name> dhcp
```

You can clear the DHCP address allocation table selected entries, or all entries. You would use this command to troubleshoot IP address allocation on the VLAN. To clear entries, use the following command:

```
clear vlan <vlan_name> dhcp-address-allocation [[all {offered | assigned | declined | expired}] | <ipaddress>]
```

Displaying DHCP Information

To display the DHCP configuration, including the DHCP range, DHCP lease timer, network login lease timer, DHCP-enabled ports, IP address, MAC address, and time assigned to each end device, use the following command:

```
show dhcp-server {vlan <vlan_name>}
```

The next two commands were retained for compatibility with earlier versions of ExtremeWare. To view only the address allocation of the DHCP server on a VLAN, use the following command:

```
show {vlan} <vlan_name> dhcp-address-allocation
```

To view only the configuration of the DHCP server on a VLAN, use the following command:

```
show {vlan} <vlan_name> dhcp-config
```

IP Security

This section describes a collection of IP security features implemented in ExtremeXOS software. If you configure any of the features described in this section, you can enhance your network security by controlling which hosts are granted or not granted access to your network.

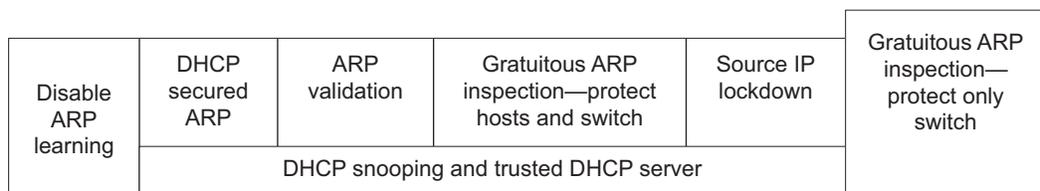
The IP security features described in this section are:

- [DHCP Snooping and Trusted DHCP Server on page 846](#)
- [Source IP Lockdown on page 853](#)

- [ARP Learning on page 855](#)
- [Gratuitous ARP Protection on page 857](#)
- [ARP Validation on page 859](#)

Figure 106 displays the dependencies of IP security. Any feature that appears directly above another feature depends on it. For example, to configure ARP validation, you must configure DHCP snooping and trusted DHCP server.

Figure 106: IP Security Dependencies



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NOTE

IP security features are supported on link aggregation ports with the exception of DHCP snooping with the `block-mac` option and source IP lockdown. You can enable IP security on pre-existing trunks, but you cannot make IP security-enabled ports into trunks without first disabling IP security.



NOTE

Enabling IP security and Network Login on the same port is not supported.

DHCP Snooping and Trusted DHCP Server

A fundamental requirement for most of the IP security features described in this section is to configure DHCP snooping and trusted DHCP server. DHCP snooping enhances security by filtering untrusted DHCP messages and by building and maintaining a DHCP bindings database. Trusted DHCP server also enhances security by forwarding DHCP packets from only configured trusted servers within your network.

The DHCP bindings database contains the IP address, MAC Address, VLAN ID, and port number of the untrusted interface or client. If the switch receives a DHCP ACK message and the IP address does not exist in the DHCP bindings database, the switch creates an entry in the DHCP bindings database. If the switch receives a DHCP RELEASE, NAK or DECLINE message and the IP address exists in the DHCP bindings database, the switch removes the entry.

You can enable DHCP snooping on a per port, per VLAN basis and trusted DHCP server on a per-vlan basis. If configured for DHCP snooping, the switch snoops DHCP packets on the indicated ports and builds a DHCP bindings database of IP address and MAC address bindings from the received packets. If configured for trusted DHCP server, the switch forwards only DHCP packets from the trusted servers. The switch drops DHCP packets from other DHCP snooping-enabled ports.

In addition, to prevent rogue DHCP servers from farming out IP addresses, you can optionally configure a specific port or set of ports as trusted ports. Trusted ports do not block traffic; rather, the

switch forwards any DHCP server packets that appear on trusted ports. When configured to do so, the switch drops packets from DHCP snooping-enabled ports and causes one of the following user-configurable actions: disables the port temporarily, disables the port permanently, blocks the violating MAC address temporarily, blocks the violating MAC address permanently, and so on.

Configuring DHCP Snooping

By default DHCP snooping is disabled on the switch. To enable DHCP snooping on the switch, use the following command:

```
enable ip-security dhcp-snooping {vlan} <vlan_name> ports [all | <ports>] violation-
action [drop-packet {[block-mac | block-port] [duration <duration_in_seconds> |
permanently] | none}}] {snmp-trap}
```



NOTE

Snooping IP fragmented DHCP packets is not supported.

The violation action setting determines what action(s) the switch takes when a rogue DHCP server packet is seen on an untrusted port or the IP address of the originating server is not among those of the configured trusted DHCP servers. The DHCP server packets are DHCP OFFER, ACK and NAK. The following list describes the violation actions:

- `block-mac`—The switch automatically generates an ACL to block the MAC address on that port. The switch does not blackhole that MAC address in the FDB. The switch can either temporarily or permanently block the MAC address.
- `block-port`—The switch blocks all traffic on that port by disabling the port either temporarily or permanently.
- `none`—The switch takes no action to drop the rogue DHCP packet or block the port, and so on. In this case, DHCP snooping continues to build and manage the DHCP bindings database and DHCP forwarding will continue in hardware as before. This option can be used when the intent is only to monitor the IP addresses being assigned by the DHCP server.



NOTE

You must enable DHCP snooping on both the DHCP server port as well as on the client port. The latter ensures that DHCP client packets (DHCP Request, DHCP Release etc.) are processed appropriately.

Any violation that occurs causes the switch to generate an Event Management System (EMS) log message. You can configure to suppress the log messages by configuring EMS log filters. For more information about EMS, see the section “[Using the Event Management System/Logging](#)” in [Chapter 11, “Status Monitoring and Statistics.”](#)

To disable DHCP snooping on the switch, use the following command:

```
disable ip-security dhcp-snooping {vlan} <vlan_name> ports [all | <ports>]
```

Configuring Trusted DHCP Server

To configure a trusted DHCP server on the switch, use the following command:

```
configure trusted-servers {vlan} <vlan_name> add server <ip_address> trust-for dhcp-
server
```

You can configure a maximum of eight trusted DHCP servers on the switch.

If you configure one or more trusted ports, the switch assumes that all DHCP server packets on the trusted port are valid. For more information about configuring trusted ports, see the next section [“Configuring Trusted DHCP Ports.”](#)

To delete a trusted DHCP server, use the following command:

```
configure trusted-servers vlan <vlan_name> delete server <ip_address> trust-for dhcp-server
```

Configuring Trusted DHCP Ports

To enable DHCP snooping, use the following command:

```
enable ip-security dhcp-snooping {vlan} <vlan_name> ports [all | <ports>] violation-action [drop-packet {[block-mac | block-port] [duration <duration_in_seconds> | permanently] | none}} {snmp-trap}
```

For more information about DHCP snooping see, [“Configuring DHCP Snooping” on page 847.](#)

Trusted ports do not block traffic; rather, the switch forwards any DHCP server packets that appear on trusted ports. Depending on your DHCP snooping configuration, the switch drops packets and can disable the port temporarily, disable the port permanently, block the MAC address temporarily, block the MAC address permanently, and so on.

To enable trusted ports on the switch, use the following command:

```
configure trusted-ports [<ports>|all] trust-for dhcp-server
```

To disable trusted ports on the switch, use the following command:

```
unconfigure trusted-ports [<ports>|all] trust-for dhcp-server
```

Displaying DHCP Snooping and Trusted Server Information

To display the DHCP snooping configuration settings, use the following command:

```
show ip-security dhcp-snooping {vlan} <vlan_name>
```

The following is sample output from this command:

```
DHCP Snooping enabled on ports: 1:2, 1:3, 1:4, 1:7, 1:9
Trusted Ports: 1:7
Trusted DHCP Servers: None
-----
Port      Violation-action
-----
1:2      none
1:3      drop-packet
1:4      drop-packet, block-mac permanently
1:7      none
1:9      drop-packet, snmp-trap
```

To display the DHCP bindings database, use the following command:

```
show ip-security dhcp-snooping entries {vlan} <vlan_name>
```

The following is sample output from this command:

```
-----
Vlan: dhcpVlan
-----
IP Addr          MAC Addr          Server   Client
-----          -
172.16.100.9     00:90:27:c6:b7:65  1:1     1:2
```

Clearing DHCP Snooping Entries

Existing DHCP snooping entries can be cleared by using the following command. (Note that this will also clear out any associated Source IP Lockdown and DHCP Secured ARP entries.)

```
clear ip-security dhcp-snooping entries {vlan} <vlan_name>
```

Configuring the DHCP Relay Agent Option (Option 82) at Layer 2

This section describes how to configure the DHCP Relay agent option for Layer 2 forwarded DHCP packets. The DHCP relay agent option feature inserts a piece of information, called option 82, into any DHCP request packet that is to be relayed by the switch. Similarly, if a DHCP reply received by the switch contains a valid relay agent option, the option will be stripped from the packet before it is relayed to the client. This is a Layer 2 option that functions only when the switch is not configured as a Layer 3 BOOTP relay.

The **Agent remote ID sub-option** always contains the Ethernet MAC address of the relaying switch. You can display the Ethernet MAC address of the switch by issuing the `show switch` command.

The contents of the inserted option 82 sub-options is as follows:

Table 96: Contents of the Inserted Option 82 Sub-options

Code (1 byte)	Length (1 byte)	Sub-Option (1 byte)	Length (1 byte)	Value (1-32 bytes)	Sub-Option (1 byte)	Length (1 byte)	Switch MAC address (6 bytes)
82		1 (Circuit ID)	1-32	vlan_info- port_info	2 (Remote ID)	6	

To enable the DHCP relay agent option at Layer 2, use the following command:

```
configure ip-security dhcp-snooping information option
```



NOTE

When DHCP relay is configured in a DHCP snooping environment, the relay agent IP address should be configured as the trusted server.

When DHCP option 82 is enabled, two types of packets need to be handled:

- **DHCP Request:** When the switch (relay agent) receives a DHCP request, option 82 is added at the end of the packet. If the option has already been enabled, then the action taken depends on the configured policy (drop packet, keep existing option 82 value, or replace the existing option). Unless configured otherwise using the `configure ip-security dhcp-snooping information circuit-`

`id vlan-information`, the `vlan_info` portion of the circuit ID added will be the VLAN ID of the ingress VLAN.

- **DHCP Reply:** When the option 82 information check is enabled, the packets received from the DHCP server are checked for option 82 information. If the remote ID sub-option is the switch's MAC address, the packet is sent to the client; if not, the packet is dropped. If the check is not enabled, the packets are forwarded as-is.

To disable the DHCP relay agent option, use the following command:

```
unconfigure ip-security dhcp-snooping information option
```

In some instances, a DHCP server may not properly handle a DHCP request packet containing a relay agent option. To prevent DHCP reply packets with invalid or missing relay agent options from being forwarded to the client, use the following command:

```
configure ip-security dhcp-snooping information check
```

To disable checking of DHCP replies, use this command:

```
unconfigure ip-security dhcp-snooping information check
```

A DHCP relay agent may receive a client DHCP packet that has been forwarded from another relay agent. If this relayed packet already contains a relay agent option, then the switch will handle this packet according to the configured DHCP relay agent option policy. The possible actions are to replace the option information, to keep the information, or to drop packets containing option 82 information. To configure this policy, use the following command:

```
configure ip-security dhcp-snooping information policy
```

The default relay policy is replace. To configure the policy to the default, use this command:

```
unconfigure ip-security dhcp-snooping information policy
```

The Layer 2 relay agent option allows you to configure the circuit ID on a VLAN or port basis., the Circuit-ID can contain a variable length (up to 32 bytes long) ASCII string with the following format:

```
<VLAN Info>--<Port Info>
```

If the configuration of either `VLAN Info` or `Port Info` causes the total string length of `<VLAN Info>--<Port Info>` to exceed 32 bytes, then it is truncated to 32 bytes. The string is not NULL terminated, since the total circuit ID length is being specified.

For a DHCP client packet ingressing on a VLAN with the VLAN ID equal to 200 and the ingress port at 3:5, the following are true:

- When neither `VLAN Info` or `Port Info` is specified, circuit ID value is = 200-3005
- When `VLAN Info` is configured to `SomeInfo` and `Port Info` is not specified, the circuit ID value is `SomeInfo-3005`
- When `VLAN Info` is not specified and `Port Info` is configured to `User1`, the circuit ID value is `200-User1`
- When `VLAN Info` is configured to `SomeInfo` and `Port Info` to `User1`, the circuit ID value is `SomeInfo-User1`

`VLAN Info` is configurable per VLAN. When not explicitly configured for a VLAN, `VLAN Info` defaults to the ASCII string representation of the ingress VLAN ID. To configure the circuit ID on a VLAN, use the following command:

```
configure ip-security dhcp-snooping information circuit-id vlan-information
```

To unconfigure the circuit ID on a VLAN, use the following command:

```
unconfigure ip-security dhcp-snooping information circuit-id vlan-information
```

`Port Info` is configurable. When not explicitly configured for a port, `port info` defaults to the ASCII representation of the ingress port's SNMP ifIndex. To configure the port information portion of the circuit-ID, use the following command:

```
configure ip-security dhcp-snooping information circuit-id port-information port
```

To unconfigure the port information portion of the circuit-ID, use the following command:

```
unconfigure ip-security dhcp-snooping information circuit-id port-information ports
```



NOTE

When this feature is enabled, all DHCP traffic must be forwarded in slowpath only, which means that this feature functions only in the context of IP Security and only on interfaces where DHCP snooping is enabled in enforcement (violation-action of 'drop') mode, in other words with DHCP snooping not configured with a violation-action of 'none' (which is pure monitoring mode).

Configuring DHCP Binding

The DHCP bindings database contains the IP address, MAC address, VLAN ID, and port number of the client. The user can add or delete the static IP to the MAC DHCP binding entries using the following commands:

```
configure ip-security dhcp-bindings add
```

```
configure ip-security dhcp-bindings delete
```

You can specify the storage details of the DHCP binding database. Use the following commands to specify the DHCP binding database location, filename, write-interval, and write threshold limits:

```
configure ip-security dhcp-bindings storage filename
```

```
configure ip-security dhcp-bindings storage location
```

```
configure ip-security dhcp-bindings storage
```

You can upload the DHCP binding database periodically (once every 10 seconds) by enabling the DHCP binding restoration. Upload the latest DHCP binding database using the upload command:

```
enable ip-security dhcp-bindings restoration
```

The periodic backup of the DHCP binding database can be disabled using the following command:

```
disable ip-security dhcp-bindings restoration
```

For information about configuring option 82 at Layer 3, see [“Configuring the DHCP Relay Agent Option \(Option 82\) at Layer 3”](#) on page 1236.

Example of Option 82 Configuration. The following example describes Option 82 configuration for circuit ID fields.

```
create vlan v1
conf v1 add ports 21
```

```

enable ip-security dhcp-snooping v1 ports all violation-action drop-packet
configure trusted-ports 21 trust-for dhcp-server
conf ip-security dhcp-snooping information option
conf ip-security dhcp-snooping information check
conf ip-security dhcp-snooping information circuit-id vlan-information
ServiceProvider-1 v1
conf ip-security dhcp-snooping information circuit-id port-information cutomer-1 port
1
conf ip-security dhcp-snooping information circuit-id port-information cutomer-2 port
2

```

CLI display output

=====

```
* X450e-24p.48 # sh ip-security dhcp-snooping v1
```

```
DHCP Snooping enabled on ports: 21
```

```
Trusted Ports: 21
```

```
Trusted DHCP Servers: None
```

```
Bindings Restoration      : Disabled
```

```
Bindings Filename        :
```

```
Bindings File Location   :
```

```
    Primary Server       : None
```

```
    Secondary Server     : None
```

```
Bindings Write Interval  : 30 minutes
```

```
Bindings last uploaded at:
```

```
-----
```

```
Port          Violation-action
```

```
-----
```

```
21            drop-packet
```

```
* X450e-24p.49 # show ip-security dhcp-snooping information-option
```

```
Information option insertion: Enabled
```

```
Information option checking : Enabled
```

```
Information option policy   : Replace
```

```
* X450e-24p.50 #
```

```
* X450e-24p.51 # sh ip-security dhcp-snooping information-option circuit-id vlan-
information
```

```
Vlan          Circuit-ID vlan information string
```

```
----
```

```
Default       1 (Default i.e. vlan-id)
```

```
Mgmt         4095 (Default i.e. vlan-id)
```

```
v1           ServiceProvider-1
```

```
Note: The full Circuit ID string has the form '<Vlan Info>-<Port Info>'
```

```
* X450e-24p.52
```

```
* X450e-24p.52 # sh ip-security dhcp-snooping information-option circuit-id port-
information ports all
```

```
Port          Circuit-ID Port information string
```

```
----
```

```
1            cutomer-1
```

```
2            cutomer-2
```

```
3            1003
```

```
4            1004
```

5	1005
6	1006
7	1007
8	1008
9	1009
10	1010
11	1011
12	1012
13	1013
14	1014
15	1015
16	1016
17	1017
18	1018
19	1019
20	1020
21	1021
22	1022
23	1023
24	1024
25	1025
26	1026

Note: The full Circuit ID string has the form '<Vlan Info>-<Port Info>'

* X450e-24p.53 #

Source IP Lockdown

Another type of IP security prevents IP address spoofing by automatically placing source IP address filters on specified ports. This feature, called source IP lockdown, allows only traffic from a valid DHCP-assigned address obtained by a DHCP snooping-enabled port to enter the network. In this way, the network is protected from attacks that use random source addresses for their traffic. With source IP lockdown enabled, end systems that have a DHCP address assigned by a trusted DHCP server can access the network, but traffic from others, including those with static IP addresses is dropped at the switch.

Source IP lockdown is linked to the “DHCP snooping” feature. The same DHCP bindings database created when you enable DHCP snooping is also used by source IP lockdown to create ACLs that permit traffic from DHCP clients. All other traffic is dropped. In addition, the DHCP snooping violation action setting determines what action(s) the switch takes when a rogue DHCP server packet is seen on an untrusted port.

When source IP lockdown is enabled on a port, a default ACL is created to deny all IP traffic on that port. Then an ACL is created to permit DHCP traffic on specified ports. Each time source IP lockdown is enabled on another port, the switch creates ACLs to allow DHCP packets and to deny all IP traffic for that particular port.

Source IP lockdown is enabled on a per-port basis; it is not available at the VLAN level. If source IP lockdown is enabled on a port, the feature is active on the port for all VLANs to which the port belongs.

**NOTE**

The source IP lockdown feature works only when hosts are assigned IP address using DHCP; source IP lockdown does not function for statically configured IP addresses.

The source IP lockdown ACLs listed in table are applied per port (in order of precedence from highest to lowest.)

Table 97: Source IP Lockdowns Applied Per-port

ACL Name	Match Condition	Action	When Applied	Comments
esSrcIpLockdown_<portIfIndex>_<source IP in hex>	Source IP	Permit	Runtime	Multiple ACLs of this type can be applied, one for each permitted client.
esSrcIpLockdown_<portIfIndex>_1	Proto UDP, Dest Port 67	Permit	Configuration time	
esSrcIpLockdown_<portIfIndex>_2	Proto UDP, Dest Port 68	Permit	Configuration time	
esSrcIpLockdown_<portIfIndex>_3	Ethertype ARP	Permit	Configuration time	
esSrcIpLockdown_<portIfIndex>_4	All	Deny + count	Configuration time	

The counter has the same name as that of the rule of the catch-all ACL, so the counter is also named esSrcIpLockdown_<portIfIndex>_4.

Configuring Source IP Lockdown

To configure source IP lockdown, you must enable DHCP snooping on the ports connected to the DHCP server and DHCP client before you enable source IP lockdown. You must enable source IP lockdown on the ports connected to the DHCP client, not on the ports connected to the DHCP server. To enable DHCP snooping, use the following command:

```
enable ip-security dhcp-snooping {vlan} <vlan_name> ports [all | <ports>] violation-
action [drop-packet {[block-mac | block-port] [duration <duration_in_seconds> |
permanently] | none}}] {snmp-trap}
```

For more information about DHCP snooping see, “[Configuring DHCP Snooping](#)” on page 847.

By default, source IP lockdown is disabled on the switch. To enable source IP lockdown, use the following command:

```
enable ip-security source-ip-lockdown ports [all | <ports>]
```

To disable source IP lockdown, use the following command:

```
disable ip-security source-ip-lockdown ports [all | <ports>]
```

Displaying Source IP Lockdown Information

To display the source IP lockdown configuration on the switch, use the following command:

```
show ip-security source-ip-lockdown
```

The following is sample output from this command:

Ports	Locked IP Address
23	10.0.0.101

Clearing Source IP Lockdown Information

To remove existing source IP lockdown entries on the switch, use the following command:

```
clear ip-security source-ip-lockdown entries ports [<ports> | all]
```

ARP Learning

The address resolution protocol (ARP) is part of the TCP/IP suite used to dynamically associate a device's physical address (MAC address) with its logical address (IP address). The switch broadcasts an ARP request that contains the IP address, and the device with that IP address sends back its MAC address so that traffic can be transmitted across the network. The switch maintains an ARP table (also known as an ARP cache) that displays each MAC address and its corresponding IP address.

By default, the switch builds its ARP table by tracking ARP requests and replies, which is known as ARP learning. You can disable ARP learning so that the only entries in the ARP table are either manually added or those created by DHCP secured ARP; the switch does not add entries by tracking ARP requests and replies. By disabling ARP learning and adding a permanent entry or configuring DHCP secured ARP, you can centrally manage and allocate client IP addresses and prevent duplicate IP addresses from interrupting network operation.

This section describes the following topics:

- [Configuring ARP Learning on page 855](#)
- [Adding a Permanent Entry to the ARP Table on page 855](#)
- [Configuring DHCP Secured ARP on page 856](#)
- [Displaying ARP Information on page 856](#)

Configuring ARP Learning

As previously described, ARP learning is enabled by default. The switch builds its ARP table by tracking ARP requests and replies.

To disable ARP learning on one or more ports in a VLAN, use the following command:

```
disable ip-security arp learning learn-from-arp {vlan} <vlan_name> ports [all | <ports>]
```

To re-enable ARP learning on one or more ports in a VLAN, use the following command:

```
enable ip-security arp learning learn-from-arp {vlan} <vlan_name> ports [all | <ports>]
```

Adding a Permanent Entry to the ARP Table

If you disable ARP learning, you must either manually add a permanent entry to the ARP table or configure DHCP secured ARP to populate the ARP table.

To manually add a permanent entry to the ARP table, use the following command:

```
configure iparp add <ip_addr> {vr <vr_name>} <mac>
```

For more detailed information about this command and IP routing, see [Chapter 31, “IPv4 Unicast Routing.”](#)

Configuring DHCP Secured ARP

Another method available to populate the ARP table is DHCP secured ARP. DHCP secured ARP requires that ARP entries be added to or deleted from the ARP table only when the DHCP server assigns or re-assigns an IP address. These entries are known as a secure ARP entry. If configured, the switch adds the MAC address and its corresponding IP address to the ARP table as a permanent ARP entry. Regardless of other ARP requests and replies seen by the switch, the switch does not update secure ARP entries. DHCP secured ARP is linked to the “DHCP snooping” feature. The same DHCP bindings database created when you enabled DHCP snooping is also used by DHCP secured ARP to create secure ARP entries. The switch only removes secure ARP entries when the corresponding DHCP entry is removed from the trusted DHCP bindings database.



NOTE

If you enable DHCP secured ARP on the switch without disabling ARP learning, ARP learning continues which allows insecure entries to be added to the ARP table.

Before you configure DHCP secured ARP, you must enable DHCP snooping on the switch. To enable DHCP snooping, use the following command:

```
enable ip-security dhcp-snooping {vlan} <vlan_name> ports [all | <ports>] violation-  
action [drop-packet {[block-mac | block-port] [duration <duration_in_seconds> |  
permanently] | none}}] {snmp-trap}
```

For more information about DHCP snooping see, “[Configuring DHCP Snooping](#)” on page 847.

By default, DHCP secured ARP learning is disabled. To enable DHCP secured ARP, use the following command:

```
enable ip-security arp learning learn-from-dhcp {vlan} <vlan_name> ports [all |  
<ports>]
```

DHCP Secured ARP must be enabled on the DHCP server port as well as the DHCP client ports. To disable DHCP secured ARP, use the following command:

```
disable ip-security arp learning learn-from-dhcp {vlan} <vlan_name> ports [all |  
<ports>]
```



NOTE

You must enable DHCP secured ARP on the DHCP server as well as on the client ports. DHCP snooping, as always, must also be enabled on both the server and client ports.

Displaying ARP Information

To display how the switch builds an ARP table and learns MAC addresses for devices on a specific VLAN and associated member ports, use the following command:

```
show ip-security arp learning {vlan} <vlan_name>
```

The following is sample output from this command:

Port	Learn-from
2:1	ARP
2:2	DHCP
2:3	ARP
2:4	None
2:5	ARP
2:6	ARP
2:7	ARP
2:8	ARP

To view the ARP table, including permanent and DHCP secured ARP entries, use the following command:

```
show iparp {<ip_addre> | <mac> | vlan <vlan_name> | permanent} {vr <vr_name>}
```



NOTE

DHCP secured ARP entries are stored as static entries in the ARP table.

Gratuitous ARP Protection

When a host sends an ARP request to resolve its own IP address it is called gratuitous ARP. A gratuitous ARP request is sent with the following parameters:

- Destination MAC address—FF:FF:FF:FF:FF:FF (broadcast)
- Source MAC address—Host's MAC address
- Source IP address = Destination IP address—IP address to be resolved

In a network, gratuitous ARP is used to:

- Detect duplicate IP address

In a properly configured network, there is no ARP reply for a gratuitous ARP request. However, if another host in the network is configured with the same IP address as the source host, then the source host receives an ARP reply.
- Announce that an IP address has moved or bonded to a new network interface card (NIC)

If you change a system NIC, the MAC address to its IP address mapping also changes. When you reboot the host, it sends an ARP request packet for its own IP address. All of the hosts in the network receive and process this packet. Each host updates their old mapping in the ARP table with this new mapping
- Notify a Layer 2 switch that a host has moved from one port to another port

However, hosts can launch man-in-the-middle attacks by sending out gratuitous ARP requests for the router's IP address. This results in hosts sending their router traffic to the attacker, and the attacker forwarding that data to the router. This allows passwords, keys, and other information to be intercepted.

To protect against this type of attack, the router sends out its own gratuitous ARP request to override the attacker whenever a gratuitous ARP request broadcast packet with the router's IP address as the source is received on the network.

If you enable both DHCP secured ARP and gratuitous ARP protection, the switch protects its own IP address and those of the hosts that appear as secure entries in the ARP table.

Configuring Gratuitous ARP

You enable the gratuitous ARP feature on a per VLAN basis, not on a per port basis. The validation is done for all gratuitous ARP packets received on a VLAN in which this feature is enabled irrespective of the port in which the packet is received.

When enabled, the switch generates gratuitous ARP packets when it receives a gratuitous ARP request where either of the following is true:

- The sender IP is the same as the switch VLAN IP address and the sender MAC address is not the switch MAC address.
- The sender IP is the same as the IP of a static entry in the ARP table and the sender MAC address is not the static entry's MAC address.

When the switch generates an ARP packet, the switch generates logs and traps.

You can enable gratuitous ARP protection with the following command:

```
enable ip-security arp gratuitous-protection {vlan} [all | <vlan_name>]
```

In addition, to protect the IP addresses of the hosts that appear as secure entries in the ARP table, use the following commands to enable DHCP snooping, DHCP secured ARP, and gratuitous ARP on the switch:

- `enable ip-security dhcp-snooping {vlan} <vlan_name> ports [all | <ports>] violation-action [drop-packet {[block-mac | block-port] [duration <duration_in_seconds> | permanently] | none}] {snmp-trap}`
- `enable ip-security arp learning learn-from-dhcp {vlan} <vlan_name> ports [all | <ports>]`
- `enable ip-security arp gratuitous-protection {vlan} [all | <vlan_name>]`

To disable gratuitous ARP protection, use the following command:

```
disable ip-security arp gratuitous-protection {vlan} [all | <vlan_name>]
```

In ExtremeXOS 11.5 and earlier, you enable gratuitous ARP protection with the following command:

```
enable iparp gratuitous protect vlan <vlan-name>
```

And you disable gratuitous ARP protection with the following command:

```
disable iparp gratuitous protect vlan <vlan-name>
```

Displaying Gratuitous ARP Information

To display information about gratuitous ARP, use the following command:

```
show ip-security arp gratuitous-protection
```

The following is sample output from this command:

```
Gratuitous ARP Protection enabled on following VLANs:
Default, test
```

ARP Validation

ARP validation is also linked to the “DHCP snooping” feature. The same DHCP bindings database created when you enabled DHCP snooping is also used to validate ARP entries arriving on the specified ports.

Validation Option	ARP Request Packet Type	ARP Response Packet Type
DHCP		Source IP is not present in the DHCP snooping database OR is present but Source Hardware Address doesn't match the MAC in the DHCP bindings entry
IP	Source IP == Mcast OR Target IP == Mcast OR Source IP is not present in the DHCP snooping database OR Source IP exists in the DHCP bindings database but Source Hardware Address doesn't match the MAC in the DHCP bindings entry	Source IP == Mcast OR Target IP == Mcast
Source-MAC	Ethernet source MAC does not match the Source Hardware Address	Ethernet source MAC does not match the Source Hardware Address.
Destination-MAC		Ethernet destination MAC does not match the Target Hardware Address

Depending on the options specified when enabling ARP validation, the following validations are done. Note that the 'DHCP' option does not have to be specified explicitly, it is always implied when ARP validation is enabled.

Configuring ARP Validation

Before you configure ARP validation, you must enable DHCP snooping on the switch. To enable DHCP snooping, use the following command:

```
enable ip-security dhcp-snooping {vlan} <vlan_name> ports [all | <ports>] violation-
action [drop-packet {[block-mac | block-port] [duration <duration_in_seconds> |
permanently] | none}}] {snmp-trap}
```

For more information about DHCP snooping see, “[Configuring DHCP Snooping](#)” on page 847.

By default, ARP validation is disabled. To enable and configure ARP validation, use the following command:

```
enable ip-security arp validation {destination-mac} {source-mac} {ip} {vlan}
<vlan_name> [all | <ports>] violation-action [drop-packet {[block-port] [duration
<duration_in_seconds> | permanently}}] {snmp-trap}
```

The violation action setting determines what action(s) the switch takes when an invalid ARP is received.

Any violation that occurs causes the switch to generate an Event Management System (EMS) log message. You can configure to suppress the log messages by configuring EMS log filters. For more information about EMS, see the section “[Using the Event Management System/Logging](#)” in Chapter 11, “[Status Monitoring and Statistics](#).”

To disable ARP validation, use the following command:

```
disable ip-security arp validation {vlan} <vlan_name> [all | <ports>]
```

Displaying ARP Validation Information

To display information about ARP validation, use the following command:

```
show ip-security arp validation {vlan} <vlan_name>
```

The following is sample output from this command:

```
-----
Port      Validation          Violation-action
-----
7         DHCP                drop-packet, block-port for 120 seconds, snmp-trap
23        DHCP                drop-packet, block-port for 120 seconds, snmp-trap
-----
```

Denial of Service Protection

A Denial-of-Service (DoS) attack occurs when a critical network or computing resource is overwhelmed and rendered inoperative in a way that legitimate requests for service cannot succeed. In its simplest form, a Denial of Service attack is indistinguishable from normal heavy traffic. There are some operations in any switch or router that are more costly than others, and although normal traffic is not a problem, exception traffic must be handled by the switch's CPU in software.

Some packets that the switch processes in the CPU software include:

- Traffic resulting from new MAC learning (Only the BlackDiamond 8800 and the Summit family switches learn in hardware.)



NOTE

When certain features such as Network Login are enabled, hardware learning is disabled to let software control new MAC learning.

- Routing and control protocols including ICMP, BGP, OSPF, STP, EAPS, ESRP, and so forth
- Switch management traffic (switch access by Telnet, SSH, HTTP, SNMP, and so forth)
- Other packets directed to the switch that must be discarded by the CPU

If any one of these functions is overwhelmed, the CPU may be too busy to service other functions and switch performance will suffer. Even with very fast CPUs, there will always be ways to overwhelm the CPU with packets that require costly processing.

DoS Protection is designed to help prevent this degraded performance by attempting to characterize the problem and filter out the offending traffic so that other functions can continue. When a flood of CPU bound packets reach the switch, DoS Protection will count these packets. When the packet count nears the alert threshold, packets headers will be saved. If the threshold is reached, then these headers are analyzed, and a hardware access control list (ACL) is created to limit the flow of these packets to the CPU. This ACL will remain in place to provide relief to the CPU. Periodically, the ACL will expire, and if the attack is still occurring, it will be re-enabled. With the ACL in place, the CPU will have the cycles to process legitimate traffic and continue other services.



NOTE

User-created ACLs take precedence over the automatically applied DoS protect ACLs.

DoS Protection will send a notification when the notify threshold is reached.

You can also specify some ports as trusted ports, so that DoS protection will not be applied to those ports.

Configuring Simulated Denial of Service Protection

The conservative way to deploy DoS protection is to use the simulated mode first. In simulated mode, DoS protection is enabled, but no ACLs are generated. To enable the simulated mode, use the following command:

```
enable dos-protect simulated
```

This mode is useful to gather information about normal traffic levels on the switch. This will assist in configuring denial of service protection so that legitimate traffic is not blocked.

The remainder of this section describes how to configure DoS protection, including alert thresholds, notify thresholds, ACL expiration time, and so on.

Configuring Denial of Service Protection

To enable or disable DoS protection, use the following commands:

```
enable dos-protect  
disable dos-protect
```

After enabling DoS protection, the switch will count the packets handled by the CPU and periodically evaluate whether to send a notification and/or create an ACL to block offending traffic. You can configure a number of the values used by DoS protection if the default values are not appropriate for your situation.

The values that you can configure are:

- interval—How often, in seconds, the switch evaluates the DoS counter (default: 1 second)
- alert threshold—The number of packets received in an interval that will generate an ACL (default: 4000 packets)
- notify threshold—The number of packets received in an interval that will generate a notice (default: 3500 packets)
- ACL expiration time—The amount of time, in seconds, that the ACL will remain in place (default: 5 seconds)

To configure the interval at which the switch checks for DoS attacks, use the following command:

```
configure dos-protect interval <seconds>
```

To configure the alert threshold, use the following command:

```
configure dos-protect type l3-protect alert-threshold <packets>
```

To configure the notification threshold, use the following command:

```
configure dos-protect type l3-protect notify-threshold <packets>
```

To configure the ACL expiration time, use the following command:

```
configure dos-protect acl-expire <seconds>
```

Configuring Trusted Ports

Traffic from trusted ports will be ignored when DoS protect counts the packets to the CPU. If we know that a machine connected to a certain port on the switch is a safe "trusted" machine, and we know that we will not get a DoS attack from that machine, the port where this machine is connected to can be configured as a trusted port, even though a large amount of traffic is going through this port.

To configure the trusted ports list, use the following command:

```
configure dos-protect trusted-ports [ports [<ports> | all] | add-ports [<ports-to-add>
| all] | delete-ports [<ports-to-delete> | all] ]
```

Displaying DoS Protection Settings

To display the DoS protection settings, use the following command:

```
show dos-protect {detail}
```

Protocol Anomaly Protection

The Extreme chipsets contain built-in hardware protocol checkers that support port security features for security applications, such as stateless DoS protection. The protocol checkers allow users to drop the packets based on the following conditions, which are checked for ingress packets prior to the L2/L3 entry table:

- SIP = DIP for IPv4/IPv6 packets.
- TCP_SYN Flag = 0 for Ipv4/Ipv6 packets
- TCP Packets with control flags = 0 and sequence number = 0 for Ipv4/Ipv6 packets
- TCP Packets with FIN, URG & PSH bits set & seq. number = 0 for Ipv4/Ipv6 packets
- TCP Packets with SYN & FIN bits are set for Ipv4/Ipv6 packets
- TCP Source Port number = TCP Destination Port number for Ipv4/Ipv6 packets
- First TCP fragment does not have the full TCP header (less than 20bytes) for Ipv4/Ipv6 packets
- TCP header has fragment offset value as 1 for Ipv4/Ipv6 packets
- UDP Source Port number = UDP Destination Port number for Ipv4/Ipv6 packets
- CMP ping packets payload is larger than programmed value of ICMP max size for Ipv4/Ipv6 packets
- Fragmented ICMP packets for Ipv4/Ipv6 packets

The protocol anomaly detection security functionality is supported by a set of anomaly-protection `enable`, `disable`, `configure`, `clear`, and `show` CLI commands. For further details, see [Chapter 23, "Security Commands,"](#) in the *ExtremeXOS Command Reference Guide*.

Flood Rate Limitation

Flood rate limitation, or storm control, is used to minimize the network impact of ingress flooding traffic. You can configure ports to accept a specified rate of packets per second. When that rate is exceeded, the port blocks traffic and drops subsequent packets until the traffic again drops below the configured rate.

To configure the rate limit, use the following command:

```
configure ports <port_list> rate-limit flood [broadcast | multicast | unknown-destmac]
[no-limit | <pps>]
```

To display rate limiting statistics, use the following command:

```
show ports {<port_list>} rate-limit flood {no-refresh}
```

Authenticating Management Sessions Through the Local Database

You can use a local database on each switch to authenticate management sessions. The local database stores user names and passwords and helps to ensure that any configuration changes to the switch can be done only by authorized users. For a detailed description of the local database of accounts and passwords (the two levels of management accounts), see [Chapter 1, “Getting Started.”](#)

You can increase authentication security using Secure Shell 2 (SSH2). SSH2 provides encryption for management sessions. For information about SSH2, see [“Secure Shell 2” on page 900.](#)



NOTE

You can also authenticate Web-based and MAC-based Network Login users through the local database. For more information, see [Chapter 21, “Network Login.”](#)

Authenticating Management Sessions Through a TACACS+ Server

You can use a Terminal Access Controller Access Control System Plus (TACACS+) server to authenticate management sessions for multiple switches. A TACACS+ server allows you to centralize the authentication database, so that you do not have to maintain a separate local database on each switch. TACACS+ servers provide the following services:

- Username and password authentication
- Command authorization (the TACACS+ server validates whether the user is authorized to execute each command within the subset of commands, based on login privilege level.)
- Accounting service (tracks authentication and authorization events)



NOTE

You can use a local database on each switch as a backup authentication service if the TACACS+ service is unavailable. When the TACACS+ service is operating, privileges defined on the TACACS+ server take precedence over privileges configured in the local database.

To use TACACS+ server features, you need the following components:

- TACACS+ client software, which is included in the ExtremeXOS software.
- A TACACS+ server, which is a third-party product.

**NOTE**

TACACS+ provides many of the same features provided by RADIUS. You cannot use RADIUS and TACACS+ at the same time.

TACACS+ is a communications protocol that is used between client and server to implement the TACACS+ service. The TACACS+ client component of the ExtremeXOS software should be compatible with any TACACS+ compliant server product. For information on installing, configuring, and managing a TACACS+ server, see the product documentation for that server.

The following sections describe how to configure the ExtremeXOS TACACS+ client component in the ExtremeXOS software:

- [Configuring the TACACS+ Client for Authentication and Authorization on page 864](#)
- [Configuring the TACACS+ Client for Accounting on page 866](#)

Configuring the TACACS+ Client for Authentication and Authorization

The following sections provide information on configuring the TACACS+ client for TACACS+ authentication and authorization:

- [Specifying TACACS+ Server Addresses on page 864](#)
- [Configuring the TACACS+ Client Timeout Value on page 864](#)
- [Configuring the Shared Secret Password for TACACS+ Communications on page 865](#)
- [Enabling and Disabling the TACACS+ Client Service on page 865](#)
- [TACACS+ Configuration Example on page 865](#)

Specifying TACACS+ Server Addresses

Before the TACACS+ client software can communicate with a TACACS+ server, you must specify the server address in the client software. You can specify up to two TACACS+ servers, and you can use either an IP address or a host name to identify each server.

To configure the TACACS+ servers in the client software, use the following command:

```
configure tacacs [primary | secondary] server [<ipaddress> | <hostname>] {<tcp_port>}
client-ip <ipaddress> {vr <vr_name>}
```

To configure the primary TACACS+ server, specify `primary`. To configure the secondary TACACS+ server, specify `secondary`.

Configuring the TACACS+ Client Timeout Value

To configure the timeout if a server fails to respond, use the following command:

```
configure tacacs timeout <seconds>
```

To detect and recover from a TACACS+ server failure when the timeout has expired, the switch makes one authentication attempt before trying the next designated TACACS+ server or reverting to the local database for authentication. In the event that the switch still has IP connectivity to the TACACS+ server,

but a TCP session cannot be established, (such as a failed TACACS+ daemon on the server), fail over happens immediately regardless of the configured timeout value.

For example, if the timeout value is set for 3 seconds (the default value), it will take 3 seconds to fail over from the primary TACACS+ server to the secondary TACACS+ server. If both the primary and the secondary servers fail or are unavailable, it takes approximately 6 seconds to revert to the local database for authentication.

Configuring the Shared Secret Password for TACACS+ Communications

The shared secret is a password that is configured on each network device and TACACS+ server. The shared secret is used to verify communication between network devices and the server.

To configure the shared secret for client communications with TACACS+ servers, use the following command:

```
configure tacacs [primary | secondary] shared-secret {encrypted} <string>
```

To configure the shared secret for a primary TACACS+ server, specify `primary`. To configure the shared secret for a secondary TACACS+ server, specify `secondary`.

Do not use the `encrypted` keyword to set the shared secret. The `encrypted` keyword prevents the display of the shared secret in the `show configuration` command output.

Enabling and Disabling the TACACS+ Client Service

The TACACS+ client service can be enabled or disabled without affecting the client configuration. When the client service is disabled, the client does not communicate with the TACACS+ server, so authentication must take place through the another service such as the local database or a RADIUS server.



NOTE

You cannot use RADIUS and TACACS+ at the same time.

To enable the TACACS+ client service, use the following command:

```
enable tacacs
```

To disable the TACACS+ client service, use the following command:

```
disable tacacs
```

TACACS+ Configuration Example

This section provides a sample TACACS+ client configuration.

The following example:

- Specifies the primary TACACS+ server
- Specifies the shared secret for the primary TACACS+ server
- Specifies the secondary TACACS+ server
- Specifies the shared secret for the secondary TACACS+ server
- Enables the TACACS+ client on the switch

All other client configuration parameters use the default settings as described earlier in this section or in the *ExtremeXOS Command Reference Guide*.

```
configure tacacs primary server 10.201.31.238 client-ip 10.201.31.85 vr "VR-Default"
configure tacacs primary shared-secret purple
configure tacacs secondary server 10.201.31.235 client-ip 10.201.31.85 vr "VR-Default"
configure tacacs secondary shared-secret purple
enable tacacs
```

To display the TACACS+ client configuration, use the `show tacacs` command. The following is sample output from this command:

```
TACACS+: enabled
TACACS+ Authorization: disabled
TACACS+ Accounting : disabled
TACACS+ Server Connect Timeout sec: 3
Primary TACACS+ Server:
  Server name      :
  IP address       : 10.201.31.238
  Server IP Port   : 49
  Client address   : 10.201.31.85 (VR-Default)
  Shared secret    : purple
Secondary TACACS+ Server:
  Server name      :
  IP address       : 10.201.31.235
  Server IP Port   : 49
  Client address   : 10.201.31.85 (VR-Default)
  Shared secret    : purple
TACACS+ Acct Server Connect Timeout sec: 3
Primary TACACS+ Accounting Server:Not configured
Secondary TACACS+ Accounting Server:Not configured
```

Configuring the TACACS+ Client for Accounting

The following sections provide information on configuring the TACACS+ client for TACACS+ accounting:

- [Specifying the Accounting Server Addresses on page 866](#)
- [Configuring the TACACS+ Client Accounting Timeout Value on page 867](#)
- [Configuring the Shared Secret Password for TACACS+ Accounting Servers on page 867](#)
- [Enabling and Disabling TACACS+ Accounting on page 867](#)
- [TACACS+ Accounting Configuration Example on page 868](#)

Specifying the Accounting Server Addresses

Before the TACACS+ client software can communicate with an TACACS+ accounting server, you must specify the server address in the client software. You can specify up to two accounting servers, and you can use either an IP address or a host name to identify each server.

To specify TACACS+ accounting servers, use the following command:

```
configure tacacs-accounting [primary | secondary] server [<ipaddress> | <hostname>]
{<udp_port>} client-ip <ipaddress> {vr <vr_name>}
```

To configure the primary TACACS+ accounting server, specify `primary`. To configure the secondary TACACS+ accounting server, specify `secondary`.

Configuring the TACACS+ Client Accounting Timeout Value

To configure the timeout if a server fails to respond, use the following command:

```
configure tacacs-accounting timeout <seconds>
```

To detect and recover from a TACACS+ accounting server failure when the timeout has expired, the switch makes one authentication attempt before trying the next designated TACACS+ accounting server or reverting to the local database for authentication. In the event that the switch still has IP connectivity to the TACACS+ accounting server, but a TCP session cannot be established, (such as a failed TACACS+ daemon on the accounting server), fail over happens immediately regardless of the configured timeout value.

For example, if the timeout value is set for 3 seconds (the default value), it takes 3 seconds to fail over from the primary TACACS+ accounting server to the secondary TACACS+ accounting server. If both the primary and the secondary servers fail or are unavailable, it takes approximately 6 seconds to revert to the local database for authentication.

Configuring the Shared Secret Password for TACACS+ Accounting Servers

The shared secret is a password that is configured on each network device and TACACS+ accounting server. The shared secret is used to verify communication between network devices and the server.

To configure the shared secret for client communications with TACACS+ accounting servers, use the following command:

```
configure tacacs-accounting [primary | secondary] shared-secret {encrypted} <string>
```

To configure the primary TACACS+ accounting server, specify `primary`. To configure the secondary TACACS+ accounting server, specify `secondary`.

Do not use the `encrypted` keyword to set the shared secret. The `encrypted` keyword prevents the display of the shared secret in the `show configuration` command output.

Enabling and Disabling TACACS+ Accounting

After you configure the TACACS+ client with the TACACS+ accounting server information, you must enable accounting in the TACACS+ client before the switch begins transmitting the information. You must enable TACACS+ authentication in the client for accounting information to be generated. You can enable and disable accounting without affecting the current state of TACACS+ authentication.

To enable TACACS+ accounting, use the following command:

```
enable tacacs-accounting
```

To disable TACACS+ accounting, use the following command:

```
disable tacacs-accounting
```

TACACS+ Accounting Configuration Example

This section provides a sample TACACS+ client configuration for TACACS+ accounting.

The following example:

- Specifies the primary TACACS+ accounting server
- Specifies the shared secret for the primary TACACS+ accounting server
- Specifies the secondary TACACS+ accounting server
- Specifies the shared secret for the secondary TACACS+ accounting server
- Enables TACACS+ accounting on the switch

All other client configuration features use the default settings as described earlier in this section or in the *ExtremeXOS Command Reference Guide*.

```
configure tacacs-accounting primary server 10.201.31.238 client-ip 10.201.31.85 vr
"VR-Default"
configure tacacs-accounting primary shared-secret purple
configure tacacs-accounting secondary server 10.201.31.235 client-ip 10.201.31.85 vr
"VR-Default"
config tacacs-accounting secondary shared-secret purple
enable tacacs-accounting
```

To display the TACACS+ client accounting configuration, use the `show tacacs` or the `show tacacs-accounting` command. The following is sample output from the `show tacacs` command:

```
TACACS+: enabled
TACACS+ Authorization: enabled
TACACS+ Accounting : enabled
TACACS+ Server Connect Timeout sec: 3
Primary TACACS+ Server:
  Server name      :
  IP address       : 10.201.31.238
  Server IP Port: 49
  Client address: 10.201.31.85 (VR-Default)
  Shared secret   : purple
Secondary TACACS+ Server:
  Server name      :
  IP address       : 10.201.31.235
  Server IP Port: 49
  Client address: 10.201.31.85 (VR-Default)
  Shared secret   : purple
TACACS+ Acct Server Connect Timeout sec: 3
Primary TACACS+ Accounting Server:
  Server name      :
  IP address       : 10.201.31.238
  Server IP Port: 49
  Client address: 10.201.31.85 (VR-Default)
  Shared secret   : purple
Secondary TACACS+ Accounting Server:
  Server name      :
  IP address       : 10.201.31.235
  Server IP Port: 49
  Client address: 10.201.31.85 (VR-Default)
  Shared secret   : purple
```

Authenticating Management Sessions Through a RADIUS Server

You can use a Remote Authentication Dial In User Service (RADIUS) server to authenticate management sessions for multiple switches. A RADIUS server allows you to centralize the authentication database, so that you do not have to maintain a separate local database on each switch. RADIUS servers provide the following services for management sessions:

- Username and password authentication
- Command authorization (the RADIUS server validates whether the user is authorized to execute each command)
- Accounting service (tracks authentication and authorization events)



NOTE

You can use a local database on each switch as a backup authentication service if the RADIUS service is unavailable. When the RADIUS service is operating, privileges defined on the RADIUS server take precedence over privileges configured in the local database.

To use RADIUS server features, you need the following components:

- RADIUS client software, which is included in the ExtremeXOS software.
- A RADIUS server, which is a third-party product.



NOTE

RADIUS provides many of the same features provided by TACACS+. You cannot use RADIUS and TACACS+ at the same time.

RADIUS is a communications protocol (RFC 2138) that is used between client and server to implement the RADIUS service. The RADIUS client component of the ExtremeXOS software should be compatible with any RADIUS compliant server product.

The following sections provide more information on management session authentication:

- [How Extreme Switches Work with RADIUS Servers on page 869](#)
- [Configuration Overview for Authenticating Management Sessions on page 871](#)

How Extreme Switches Work with RADIUS Servers

When configured for use with a RADIUS server, an ExtremeXOS switch operates as a RADIUS client. In RADIUS server configuration, the client component is configured as a client or as a Network Access Server (NAS). Typically, an ExtremeXOS NAS provides network access to supplicants such as PCs or phones.

When a supplicant requests authentication from a switch that is configured for RADIUS server authentication, the following events occur:

- 1 The switch sends an authentication request in the form of a RADIUS Access-Request message.
- 2 The RADIUS server looks up the user in the *users* file.

- 3 The RADIUS server accepts or rejects the authentication and returns a RADIUS Access-Accept or Access-Reject message.
- 4 If authentication is accepted, the Access-Accept message can contain standard RADIUS attributes and Vendor Specific Attributes (VSAs) that can be used to configure the switch.
- 5 If authentication is accepted, the Access-Accept message can enable command authorization for that user on the switch. Command authorization uses the RADIUS server to approve or deny the execution of each command the user enters.

The ExtremeXOS switch initiates all communications with the RADIUS server. For basic authentication, the switch sends the Access-Request message, and communications with the RADIUS server is complete when the switch receives the Access-Accept or Access-Reject message. For command authorization, communications starts each time a user configured for command authorization enters a switch command. RADIUS server communications ends when command use is allowed or denied.

A key component of RADIUS server management is the attributes and VSAs that the RADIUS server can be configured to send in Access-Accept messages. VSAs are custom attributes for a specific Vendor, such as Extreme Networks. These attributes store information about a particular user and the configuration options available to the user. The RADIUS client in ExtremeXOS accepts these attributes and uses them to configure the switch in response to authentication events. The RADIUS server does not process attributes; it simply sends them when authentication is accepted. It is the switch that processes attributes.

User authentication and attributes are managed on a RADIUS server by editing text files. On the FreeRADIUS server, the user ID, password, attributes, and VSAs are stored in the *users* file, and VSAs are defined in the *dictionary* file. The dictionary file associates numbers with each attribute. When you edit the users file, you specify the text version of each attribute you define. When the RADIUS server sends attributes to the switch, it sends the attribute type numbers to reduce the network load. Some attribute values are sent as numbers too.

Command authorization is also managed on a RADIUS server by editing text files. On a FreeRADIUS server, the *profiles* file is divided into sections called *profiles*. Each profile lists command access definitions. In the users file, you can use the Profile-Name attribute to select the command profile that applies to each user managed by command authorization.

The ExtremeXOS software supports backup authentication and authorization by a secondary RADIUS server. If the first RADIUS server, which is configured as the primary RADIUS server, fails and a secondary RADIUS server is configured, the switch sends the request to the secondary RADIUS server. If neither RADIUS server is available, the switch looks up the user in the local database.

RADIUS servers can be optionally configured to work with directory services such as LDAP or Microsoft Active Directory. Because ExtremeXOS switches operate with RADIUS servers, they can benefit from the pairing of the RADIUS server and a directory service. Some guidelines for configuring FreeRADIUS with LDAP are provided later in this chapter. Since the use of the directory service requires configuration of the RADIUS server and directory service, the appropriate documentation to follow is the documentation for those products.

Configuration Overview for Authenticating Management Sessions

To configure the switch RADIUS client and the RADIUS server to authenticate management sessions, do the following:

- 1 Configure the switch RADIUS client for authentication as described in [“Configuring the RADIUS Client for Authentication and Authorization”](#) on page 873.
- 2 If you want to use RADIUS accounting, configure the switch RADIUS accounting client as described in [“Configuring the RADIUS Client for Accounting”](#) on page 874.
- 3 Configure the RADIUS server for authentication as described in [“Configuring User Authentication \(Users File\)”](#) on page 876.
- 4 If you want to configure command authorization, configure the RADIUS server as described in [“Configuring Command Authorization \(RADIUS Profiles\)”](#) on page 886.
- 5 If you want to use RADIUS accounting, configure a RADIUS accounting server as described in the documentation for your RADIUS product.

Authenticating Network Login Users Through a RADIUS Server

You can use a RADIUS server to authenticate network login users and supply configuration data that the switch can use to make dynamic configuration changes to accommodate network login users. A RADIUS server allows you to centralize the authentication database, so that you do not have to maintain a separate local database on each switch. RADIUS servers provide the following services for network login sessions:

- Username and password authentication
- Standard RADIUS attributes and Extreme Networks VSAs that the switch can use for dynamic configuration
- Accounting service (tracks authentication and authorization events)

To use RADIUS server features, you need the following components:

- RADIUS client software, which is included in the ExtremeXOS software.
- A RADIUS server, which is a third-party product.



NOTE

RADIUS provides many of the same features provided by TACACS+, but the network login feature does not work with TACACS+.

The following sections provide more information on network login session authentication:

- [How Network Login Authentication Differs from Management Session Authentication on page 872](#)
- [Configuration Overview for Authenticating Network Login Users on page 872](#)

How Network Login Authentication Differs from Management Session Authentication

Network login authentication is very similar to management session authentication. The differences are:

- Network login authentication grants network access to devices connected to a switch port, and management session authentication grants management access to the switch for configuration and management.
- The user name for network login authentication can be a MAC address.
- Standard RADIUS attributes and Extreme Networks VSAs can be used with the network login and universal port features to configure switch ports and general switch configuration parameters.
- Command authorization is not applicable because network login controls network access, not management session access.

Except for the above differences, network login authentication is the same as described in [“How Extreme Switches Work with RADIUS Servers”](#) on page 869.

Configuration Overview for Authenticating Network Login Users

To configure the switch RADIUS client and the RADIUS server to authenticate network login users, do the following:

- 1 Configure the switch RADIUS client for authentication as described in [“Configuring the RADIUS Client for Authentication and Authorization”](#) on page 873.
- 2 If you want to use RADIUS accounting, configure the switch RADIUS accounting client as described in [“Configuring the RADIUS Client for Accounting”](#) on page 874.
- 3 Configure network login on the switch as described in [Chapter 21, “Network Login.”](#)
- 4 Configure the RADIUS server for authentication and Extreme Networks VSAs as described in [“Configuring User Authentication \(Users File\)”](#) on page 876.
- 5 If you want to use the universal port feature to run configuration scripts at authentication, configure the switch universal port feature as described in [Chapter 6, “Universal Port.”](#)
- 6 If you want to use RADIUS accounting, configure a RADIUS accounting server as described in the documentation for your RADIUS product.

Configuring the RADIUS Client

The following sections describe how to configure the ExtremeXOS RADIUS client component in the ExtremeXOS software:

- [Configuring the RADIUS Client for Authentication and Authorization](#) on page 873
- [Configuring the RADIUS Client for Accounting](#) on page 874

For information on installing, configuring, and managing a RADIUS server, see the product documentation for that server and the guidelines in [“RADIUS Server Configuration Guidelines”](#) on page 876.

Configuring the RADIUS Client for Authentication and Authorization

The following sections provide information on configuring the RADIUS client for RADIUS server authentication and authorization:

- [Specifying RADIUS Server Addresses on page 873](#)
- [Configuring the RADIUS Client Timeout Value on page 873](#)
- [Configuring the Shared Secret Password for RADIUS Communications on page 873](#)
- [Enabling and Disabling the RADIUS Client Service on page 874](#)

Specifying RADIUS Server Addresses

Before the RADIUS client software can communicate with a RADIUS server, you must specify the server address in the client software. You can specify up to two RADIUS servers, and you can use either an IP address or a host name to identify each server.

To configure the RADIUS servers in the client software, use the following command:

```
configure radius {mgmt-access | netlogin} [primary | secondary] server [<ipaddress> | <hostname>] {<udp_port>} client-ip [<ipaddress>] {vr <vr_name>}
```

The default port value for authentication is 1812. The client IP address is the IP address used by the RADIUS server for communicating back to the switch.

To configure the primary RADIUS server, specify `primary`. To configure the secondary RADIUS server, specify `secondary`.

By default, switch management and network login use the same primary and secondary RADIUS servers for authentication. To specify one pair of RADIUS servers for switch management and another pair for network login, use the `mgmt-access` and `netlogin` keywords.

Configuring the RADIUS Client Timeout Value

To configure the timeout if a server fails to respond, use the following command:

```
configure radius {mgmt-access | netlogin} timeout <seconds>
```

If the timeout expires, another authentication attempt is made. After three failed attempts to authenticate, the alternate server is used. After six failed attempts, local user authentication is used.

If you do not specify the `mgmt-access` or `netlogin` keyword, the timeout interval applies to both switch management and `netlogin` RADIUS servers.

Configuring the Shared Secret Password for RADIUS Communications

The shared secret is a password that is configured on each network device (RADIUS client) and RADIUS server. The shared secret is used to verify communication between network devices and the server.

To configure the shared secret for client communications with RADIUS servers, use the following command:

```
configure radius {mgmt-access | netlogin} [primary | secondary] shared-secret {encrypted} <string>
```

To configure the shared secret for a primary RADIUS server, specify `primary`. To configure the shared secret for a secondary RADIUS server, specify `secondary`.

If you do not specify the `mgmt-access` or `netlogin` keyword, the secret applies to both the primary and secondary switch management and network login RADIUS servers.

Do not use the `encrypted` keyword to set the shared secret. The `encrypted` keyword prevents the display of the shared secret in the `show configuration` command output.

Enabling and Disabling the RADIUS Client Service

The RADIUS client service can be enabled or disabled without affecting the client configuration. When the client service is disabled, the client does not communicate with the RADIUS server, so authentication must take place through the another service such as the local database or a TACACS+ server.



NOTE

You cannot use RADIUS and TACACS+ at the same time.

To enable the RADIUS client service, use the following command:

```
enable radius {mgmt-access | netlogin}
```

To disable the RADIUS client service, use the following command:

```
disable radius {mgmt-access | netlogin}
```

If you do not specify the `mgmt-access` or `netlogin` keywords, RADIUS authentication is enabled or disabled on the switch for both management and network login.

Configuring the RADIUS Client for Accounting

The following sections provide information on configuring the RADIUS client for RADIUS accounting:

- [Specifying the RADIUS Accounting Server Addresses on page 874](#)
- [Configuring the RADIUS Client Accounting Timeout Value on page 875](#)
- [Configuring the Shared Secret Password for RADIUS Accounting Servers on page 875](#)
- [Enabling and Disabling RADIUS Accounting on page 875](#)

Specifying the RADIUS Accounting Server Addresses

Before the RADIUS client software can communicate with a RADIUS accounting server, you must specify the server address in the client software. You can specify up to two accounting servers, and you can use either an IP address or a host name to identify each server.

To specify RADIUS accounting servers, use the following command:

```
configure radius-accounting {mgmt-access | netlogin} [primary | secondary] server  
[<ipaddress> | <hostname>] {<tcp_port>} client-ip [<ipaddress>] {vr <vr_name>}
```

The default port value for accounting is 1813. The client IP address is the IP address used by the RADIUS server for communicating back to the switch.

To configure the primary RADIUS accounting server, specify `primary`. To configure the secondary RADIUS accounting server, specify `secondary`.

By default, switch management and network login use the same primary and secondary RADIUS servers for accounting. To specify one pair of RADIUS accounting servers for switch management and another pair for network login, use the `mgmt-access` and `netlogin` keywords.

Configuring the RADIUS Client Accounting Timeout Value

To configure the timeout if a server fails to respond, use the following command:

```
configure radius-accounting {mgmt-access | netlogin} timeout <seconds>
```

If the timeout expires, another authentication attempt is made. After three failed attempts to authenticate, the alternate server is used.

Configuring the Shared Secret Password for RADIUS Accounting Servers

The shared secret is a password that is configured on each network device (RADIUS client) and RADIUS accounting server. The shared secret is used to verify communication between network devices and the server.

To configure the shared secret for client communications with RADIUS accounting servers, use the following command:

```
configure radius-accounting {mgmt-access | netlogin} [primary | secondary] shared-secret {encrypted} <string>
```

To configure the primary RADIUS accounting server, specify `primary`. To configure the secondary RADIUS accounting server, specify `secondary`.

If you do not specify the `mgmt-access` or `netlogin` keywords, the secret applies to both the primary and secondary switch management and network login RADIUS accounting servers.

Do not use the `encrypted` keyword to set the shared secret. The `encrypted` keyword prevents the display of the shared secret in the `show configuration` command output.

Enabling and Disabling RADIUS Accounting

After you configure the RADIUS client with the RADIUS accounting server information, you must enable accounting in the RADIUS client before the switch begins transmitting the information. You must enable RADIUS authentication in the client for accounting information to be generated. You can enable and disable accounting without affecting the current state of RADIUS authentication.

To enable RADIUS accounting, use the following command:

```
enable radius-accounting {mgmt-access | netlogin}
```

To disable RADIUS accounting, use the following command:

```
disable radius-accounting {mgmt-access | netlogin}
```

If you do not specify a keyword, RADIUS accounting is enabled or disabled on the switch for both management and network login.

RADIUS Server Configuration Guidelines

The RADIUS server is introduced in “[Configuring the RADIUS Client](#)” on page 872. This section describes the following:

- [Configuring User Authentication \(Users File\) on page 876](#)
- [Configuring the Dictionary File on page 885](#)
- [Configuring Command Authorization \(RADIUS Profiles\) on page 886](#)
- [Additional RADIUS Configuration Examples on page 888](#)
- [Implementation Notes for Specific RADIUS Servers on page 892](#)
- [Setting Up Open LDAP on page 894](#)



NOTE

For information on how to use and configure your RADIUS server, refer to the documentation that came with your RADIUS server.

Configuring User Authentication (Users File)

User authentication is configured in the *users* file on a FreeRADIUS server. Other RADIUS servers might use a different name and a different syntax for configuration, but the basic components of the *users* file and user authentication are the same.

For Extreme Networks switches, there are three types of *users* file entries:

- Session management entries
- Network login user entries
- Network login MAC address entries



NOTE

The “users” file is case-sensitive, and punctuation is very important for FreeRADIUS.

The following sections describe the users file entries and some of the attributes they contain:

- [Session Management Entries on page 876](#)
- [Network Login User Entries on page 877](#)
- [Network Login MAC Address Entries on page 877](#)
- [Standard RADIUS Attributes Used by Extreme Switches on page 878](#)
- [Extreme Networks VSAs on page 879](#)

Session Management Entries

The following is an example of a session management entry:

```
eric                Password = "", Service-Type = Administrative, Profile-Name = ""
                   Filter-Id = "unlim"
                   Extreme:Extreme-CLI-Authorization = Enabled
```

The key components of the example above are the user name, password, profile name, and Extreme-CLI-Authorization VSA. For simple authentication, you only need to enter the user name (eric in this example) and a password as described in the RADIUS server documentation.

Enter the attributes for each user and separate them from the others with commas as described in the RADIUS server documentation.

The Profile-Name and Extreme-CLI-Authorization attributes are required for command authorization, which is optional. For more information on specifying a profile name, see [“Configuring Command Authorization \(RADIUS Profiles\)” on page 886](#). For more information on the Extreme-CLI-Authorization VSA, see [“Extreme Networks VSAs” on page 879](#).

Network Login User Entries

The following is an example of a network login user entry:

```
Jim          Auth-Type := EAP, User-Password == "12345"
            Session-Timeout = 60,
            Termination-Action = 1,
            Extreme-Security-Profile = "user-auth LOGOFF-PROFILE=avaya-
            remove;qos=\"QP1\";",
            Extreme-Netlogin-Vlan = voice-avaya
```

The key components of the example above are the user name, password, attributes, and Extreme Networks VSAs. For simple authentication, you only need to enter the user name (Jim in this example) and a password as described in the RADIUS server documentation.

Enter the attributes for each user and separate them from the others with commas as described in the RADIUS server documentation.

In the example above, the Session-Timeout and Termination-Action attributes are examples of standard RADIUS attributes, and these are described in [“Standard RADIUS Attributes Used by Extreme Switches” on page 878](#). The Extreme-Security-Profile and Extreme-Netlogin-Vlan attributes are examples of Extreme Networks VSAs and are described in [“Extreme Networks VSAs” on page 879](#).

Network Login MAC Address Entries

The following is an example of a network login MAC address entry:

```
00040D9D12AF Auth-Type := Local, User-Password == "00040D9D12AF"
            Session-Timeout = 60,
            Termination-Action = 1,
            Extreme-Security-Profile = "user-auth LOGOFF-PROFILE=avaya
            remove;qos=\"QP1\";",
            Extreme-Netlogin-Vlan = voice-avaya
```

The key components of the example above are the MAC address, password (which is set to the MAC address), attributes, and Extreme Networks VSAs. For simple authentication, you only need to enter the MAC address (00040D9D12AF in this example) and a password as described in the RADIUS server documentation.

Enter the attributes for each user and separate them from the others with commas as described in the RADIUS server documentation.

In the example above, the Session-Timeout and Termination-Action attributes are examples of standard RADIUS attributes, and these are described in [“Standard RADIUS Attributes Used by Extreme Switches” on page 878](#). The Extreme-Security-Profile and Extreme-Netlogin-Vlan attributes are examples of Extreme Networks VSAs and are described in [“Extreme Networks VSAs” on page 879](#).

Standard RADIUS Attributes Used by Extreme Switches

The ExtremeXOS software uses standard RADIUS attributes to send information in an Access-Request message to a RADIUS server. The software also accepts some standard RADIUS attributes in the Access-Accept message that the RADIUS server sends to the switch after successful authentication. The switch ignores attributes that it is not programmed to use.

[Table 98](#) lists the standard RADIUS attributes used by the ExtremeXOS software.

Table 98: Standard RADIUS Attributes Used by Network Login

Attribute	RFC	Attribute Type	Format	Sent-in	Description
User-Name	RFC 2138	1	String	Access-Request	Specifies a user name for authentication.
Calling-Station-ID	RFC 2865	31	String	Access-Request	Identifies the phone number for the supplicant requesting authentication.
EAP-Message	RFC 3579	79	String	Access-Request, Access-Challenge, Access-Accept, and Access Reject	Encapsulates EAP packets.
Login-IP-Host	RFC 2138	14	Address	Access-Request and Access-Accept	Specifies a host to log into after successful authentication.
Message-Authenticator	RFC 3579	80	String	Access-Request, Access-Challenge, Access-Accept, and Access Reject	Contains a hash of the entire message that is used to authenticate the message.
NAS-Port-Type	RFC 2865	61	Integer	Access-Request	Identifies the port type for the port through which authentication is requested.
Service-Type	RFC 2138	6	String	Access-Accept	Specifies the granted service type in an Access-Accept message. See “Attribute 6: Service Type” on page 879 .
Session-Timeout	RFC 2865	27	Integer	Access-Accept, Access-Challenge	Specifies how long the user session can last before authentication is required.
State	RFC 2865	24	String	Access-Challenge, Access-Request	Site specific.

Table 98: Standard RADIUS Attributes Used by Network Login (Continued)

Attribute	RFC	Attribute Type	Format	Sent-in	Description
Termination-Action	RFC 2865	29	Integer	Access-Accept	Specifies how the switch should respond to service termination.
Tunnel-Medium-Type	RFC 2868	65	Integer	Access-Accept	Specifies the transport medium used when creating a tunnel for protocols (for example, VLANs) that can operate over multiple transports.
Tunnel-Private-Group-ID	RFC 2868	81	String	Access-Accept	Specifies the VLAN ID of the destination VLAN after successful authentication; used to derive the VLAN name.
Tunnel-Type	RFC 2868	64	Integer	Access-Accept	Specifies the tunneling protocol that is used.
User-Password	RFC 2138	2	String	Access-Request	Specifies a password for authentication.

Attribute 6: Service Type. Extreme Networks switches have two levels of user privilege:

- Read-only
- Read-write

Because no command line interface (CLI) commands are available to modify the privilege level, access rights are determined when you log in. For a RADIUS server to identify the administrative privileges of a user, Extreme Networks switches expect a RADIUS server to transmit the Service-Type attribute in the Access-Accept packet, after successfully authenticating the user.

Extreme Networks switches grant a RADIUS-authenticated user read-write privilege if a Service-Type value of 6 is transmitted as part of the Access-Accept message from the RADIUS server. Other Service-Type values or no value, result in the switch granting read-only access to the user. Different implementations of RADIUS handle attribute transmission differently. You should consult the documentation for your specific implementation of RADIUS when you configure users for read-write access.

Extreme Networks VSAs

Table 99 contains the Vendor Specific Attribute (VSA) definitions that a RADIUS server can send to an Extreme switch after successful authentication. These attributes must be configured on the RADIUS server along with the Extreme Networks Vendor ID, which is 1916.

Table 99: VSA Definitions for Web-Based, MAC-Based, and 802.1x Network Login

VSA	Attribute Type	Format	Sent-in	Description
Extreme-CLI-Authorization	201	Integer	Access-Accept	Specifies whether command authorization is to be enabled or disabled for the user on the ExtremeXOS switch.
Extreme-Shell-Command	202	String		

Table 99: VSA Definitions for Web-Based, MAC-Based, and 802.1x Network Login (Continued)

VSA	Attribute Type	Format	Sent-in	Description
Extreme-Netlogin-VLAN-Name	203	String	Access-Accept	Name of destination VLAN after successful authentication (must already exist on switch).
Extreme-Netlogin-URL	204	String	Access-Accept	Destination web page after successful authentication.
Extreme-Netlogin-URL-Desc	205	String	Access-Accept	Text description of network login URL attribute.
Extreme-Netlogin-Only	206	Integer	Access-Accept	Indication of whether the user can authenticate using other means, such as telnet, console, SSH, or Vista. A value of "1" (enabled) indicates that the user can only authenticate via network login. A value of "0" (disabled) indicates that the user can also authenticate via other methods.
Extreme-User-Location	208	String		
Extreme-Netlogin-VLAN-ID	209	Integer	Access-Accept	ID of destination VLAN after successful authentication (must already exist on switch).
Extreme-Netlogin-Extended-VLAN	211	String	Access-Accept	Name or ID of the destination VLAN after successful authentication (must already exist on switch). NOTE: When using this attribute, specify whether the port should be moved tagged or untagged to the VLAN. See the guidelines listed in the section " VSA 211: Extreme-Netlogin-Extended-Vlan " on page 883 for more information.
Extreme-Security-Profile	212	String	Access-Accept	Specifies a universal port profile to execute on the switch. For more information, see Chapter 6, "Universal Port."

The following sections provide additional information on using the Extreme Networks VSAs listed in [Table 99](#):

- [VSA 201: Extreme-CLI-Authorization on page 881](#)
- [VSA 203: Extreme-Netlogin-VLAN-Name on page 881](#)
- [VSA 204: Extreme-Netlogin-URL on page 882](#)
- [VSA 205: Extreme-Netlogin-URL-Desc on page 882](#)
- [VSA 206: Extreme-Netlogin-Only on page 882](#)
- [VSA 209: Extreme-Netlogin-VLAN-ID on page 883](#)
- [VSA 211: Extreme-Netlogin-Extended-Vlan on page 883](#)
- [VSA 212: Extreme-Security-Profile on page 885](#)

The examples in the following sections are formatted for use in the FreeRADIUS *users* file. If you use another RADIUS server, the format might be different.

**NOTE**

For information on how to use and configure your RADIUS server, refer to the documentation that came with your RADIUS server.

**NOTE**

For untagged VLAN movement with 802.1x netlogin, you can use all current Extreme Networks VLAN VSAs: VSA 203, VSA 209, and VSA 211.

VSA 201: Extreme-CLI-Authorization. This attribute specifies whether command authorization is to be enabled or disabled for the user on the ExtremeXOS switch. If command authorization is disabled, the user has full access to all CLI commands. If command authorization is enabled, each command the user enters is accepted or rejected based on the contents of the profiles file on the RADIUS server. For more information on RADIUS server configuration for command authorization, see [“Configuring Command Authorization \(RADIUS Profiles\)” on page 886](#).

When added to the RADIUS users file, the following example enables command authorization for the associated user:

```
Extreme: Extreme-CLI-Authorization = enabled
```

When added to the RADIUS users file, the following example disables command authorization for the associated user:

```
Extreme: Extreme-CLI-Authorization = disabled
```

VSA 203: Extreme-Netlogin-VLAN-Name. This attribute specifies a destination VLAN name that the RADIUS server sends to the switch after successful authentication. The VLAN must already exist on the switch. When the switch receives the VSA, it adds the authenticated user to the VLAN.

The following describes the guidelines for VSA 203:

- For untagged VLAN movement with 802.1x netlogin, you can use all current Extreme Networks VLAN VSAs: VSA 203, VSA 209, and VSA 211.
- To specify the VLAN name, use an ASCII string.
- When using this VSA, do not specify whether the VLAN is tagged or untagged.

Because the RADIUS server can identify a target VLAN with multiple attributes, the switch selects the appropriate VLAN or VLANs using the order:

- Extreme-Netlogin-Extended-VLAN (VSA 211)
- Extreme-Netlogin-VLAN-Name (VSA 203)
- Extreme-Netlogin-VLAN-ID (VSA 209)
- Tunnel-Private-Group-ID, but only if Tunnel-Type == VLAN(13) and Tunnel-Medium-Type == 802 (6). (See [“Standard RADIUS Attributes Used by Extreme Switches” on page 878](#).)

If none of the previously described attributes are present ISP mode is assumed, and the client remains in the configured VLAN.

When added to the RADIUS users file, the following example specifies the destination VLAN name, *purple*, for the associated user:

```
Extreme: Extreme-Netlogin-VLAN-Name = purple
```

VSA 204: Extreme-Netlogin-URL. The *Extreme-NetLogin-Url* attribute specifies a web page URL that the RADIUS server sends to the switch after successful authentication. When the switch receives the attribute in response to a Web-based network login, the switch redirects the web client to display the specified web page. If a login method other than Web-based is used, the switch ignores this attribute.

The following describes the guidelines for VSA 204:

- To specify the URL to display after authentication, use an ASCII string.
- If you do not specify a URL, the network login infrastructure uses the default redirect page URL, <http://www.extremenetworks.com>, or the URL that you configured using the `configure netlogin redirect-page` command.
- VSA 204 applies only to the web-based authentication mode of Network Login.

The following example specifies the redirection URL to use after successful authentication. To configure the redirect URL as `http://www.myhomepage.com`, add the following line:

```
Extreme: Netlogin-URL = http://www.myhomepage.com
```

VSA 205: Extreme-Netlogin-URL-Desc. The *Extreme-NetLogin-Url-Desc* attribute provides a redirection description that the RADIUS server sends to the switch after successful authentication. When the switch receives this attribute in response to a Web-based network login, the switch temporarily displays the redirect message while the web client is redirected to the web page specified by attribute 204. If a login method other than Web-based is used, the switch ignores this attribute.

The following describes the guidelines for VSA 205:

- To let the user know where they will be redirected to after authentication (specified by VSA 204), use an ASCII string to provide a brief description of the URL.
- VSA 205 applies only to the web-based authentication mode of Network Login.

The following example specifies a redirect description to send to the switch after successful authentication:

```
Extreme: Netlogin-URL-Desc = "Authentication successful. Stand by for the home page."
```

VSA 206: Extreme-Netlogin-Only. The *Extreme-Netlogin-Only* attribute can be used to allow normal authentication or restrict authentication to only the network login method. When this attribute is assigned to a user and authentication is successful, the RADIUS server sends the configured value back to the switch. The configured value is either *disabled* or *enabled*.

The Extreme switch uses the value received from the RADIUS server to determine if the authentication is valid. If the configured value is disabled, all normal authentication processes are supported (Telnet and SSH, for example), so the switch accepts the authentication. If the configured value is enabled, the switch verifies whether network login was used for authentication. If network login was used for authentication, the switch accepts the authentication. If an authentication method other than network login was used, the switch rejects the authentication.

Add the following line to the RADIUS server *users* file for users who are not restricted to network login authentication:

```
Extreme:Extreme-Netlogin-Only = Disabled
```

Add the following line to the RADIUS server *users* file for users who are restricted to network login authentication:

```
Extreme:Extreme-Netlogin-Only = Enabled
```

To reduce the quantity of information sent to the switch, the RADIUS server sends either a *1* for the *enabled* configuration or a *0* for the *disabled* configuration. These values must be configured in the RADIUS dictionary file as shown in [“Configuring the Dictionary File” on page 885](#).

VSA 209: Extreme-Netlogin-VLAN-ID. This attribute specifies a destination VLAN ID (or VLAN tag) that the RADIUS server sends to the switch after successful authentication. The VLAN must already exist on the switch. When the switch receives the VSA, it adds the authenticated user to the VLAN.

The following describes the guidelines for VSA 209:

- For untagged VLAN movement with 802.1x netlogin, you can use all current Extreme Networks VLAN VSAs: VSA 203, VSA 209, and VSA 211.
- To specify the VLAN ID, use an ASCII string.
- When using this VSA, do not specify whether the VLAN is tagged or untagged.

Because the RADIUS server can identify a target VLAN with multiple attributes, the switch selects the appropriate VLAN or VLANs using the order:

- Extreme-Netlogin-Extended-VLAN (VSA 211)
- Extreme-Netlogin-VLAN-Name (VSA 203)
- Extreme-Netlogin-VLAN-ID (VSA 209)
- Tunnel-Private-Group-ID, but only if Tunnel-Type == VLAN(13) and Tunnel-Medium-Type == 802 (6). (See [“Standard RADIUS Attributes Used by Extreme Switches” on page 878](#).)

If none of the previously described attributes are present ISP mode is assumed, and the client remains in the configured VLAN.

When added to the RADIUS users file, the following example specifies the destination VLAN ID, 234, for the associated user:

```
Extreme:Extreme-Netlogin-VLAN-ID = 234
```

VSA 211: Extreme-Netlogin-Extended-Vlan. This attribute specifies one or more destination VLANs that the RADIUS server sends to the switch after successful authentication. You can specify VLANs by VLAN name or ID (tag). The VLANs may either already exist on the switch or, if you have enabled dynamic VLANs and a non-existent VLAN tag is given, the VLAN is created.

When the switch receives the VSA, it does the following:

- Unauthenticates the user on all VLANs where it is currently authenticated during reauthentication.
- Authenticates the user on all VLANs in the VSA, or none of them.

In cases where the client is already authenticated, if a single VLAN move fails from a list of VLANs in the VSA and the move-fail-action is `authenticate`, then it is left as-is. If the client is not already authenticated (first time authentication), then it is authenticated on `learnedOnVlan` if possible. If move-fail-action is `deny` then the client is unauthenticated from all the VLANs where it is currently authenticated. There is no partial success.



NOTE

if there is one or more invalid VLAN in the VSA, the supplicant is not authenticated on any one of them.

For example if the VSA is `Uvoice;Tdata` and the VLAN `data` does not have a tag or the VLAN does not exist, then the port movement fails. Even if a single VLAN in the list is invalid the entire list is discarded and the action taken is based on move-fail-action configuration.

The following describes the guidelines for VSA 211:

- For tagged VLAN movement with 802.1x netlogin, you must use VSA 211.
- To specify the VLAN name or the VLAN ID, use an ASCII string; however, you cannot specify both the VLAN name and the VLAN ID at the same time. If the string only contains numbers, it is interpreted as the VLAN ID.
- A maximum of 10 VLANs are allowed per VSA.
- For tagged VLANs, specify `T` for tagged before the VLAN name or VLAN ID.
- For untagged VLANs, specify `U` for untagged before the VLAN name or VLAN ID.
- For movement based on the incoming port's traffic, specify the wildcard `*` before the VLAN name or VLAN ID. The behavior can be either tagged or untagged, based on the incoming port's traffic, and mimics the behavior of VSA 203 and VSA 209, respectively.
- Multiple VLAN names or VLAN IDs are separated by semicolons. When multiple vlans are defined in single VSA 211, the wildcard `*` is not allowed.
- There cannot be more than one untagged VLAN in a single VSA.
- The same VLAN cannot be both untagged and tagged in a single VSA.
- A client or supplicant can be authenticated in a only one untagged VLAN.
- The ports configured for an untagged VLAN different from the netlogin VLAN can never be added tagged to the same VLAN.
- A port can be in more than one untagged VLAN when MAC-based VLANs are enabled.

When added to the RADIUS users file, the following examples specify VLANs for the switch to assign after authentication:

```
Extreme-Netlogin-Extended-VLAN = Tvoice (Tagged VLAN named voice)
Extreme-Netlogin-Extended-VLAN = Udata (Untagged VLAN named data)
Extreme-Netlogin-Extended-VLAN = *orange (VLAN named orange, tagging dependent on
incoming traffic)
Extreme-Netlogin-Extended-VLAN = T229 (Tagged VLAN with ID 229)
Extreme-Netlogin-Extended-VLAN = U4091 (Untagged VLAN with ID 4091)
Extreme-Netlogin-Extended-VLAN = *145 (VLAN with ID 145, tagging dependent on incoming
traffic)
```

in FreeRADIUS, a tagged VLAN `voice` and a tagged VLAN `mktg` would be configured as the following:

```
Extreme-Netlogin-Extended-VLAN = "Tvoice;Tmktg;"
```

An untagged VLAN `data` and a tagged VLAN `mktg` is configured as the following:

```
Extreme-Netlogin-Extended-VLAN = "Udata;Tmktg;"
```

A tagged VLAN with VLAN ID 229 and a tagged VLAN with VLAN ID 227 is configured in FreeRADIUS as the following:

```
Extreme-Netlogin-Extended-VLAN = "T229;T227;"
```

An untagged VLAN with VLAN ID 4091 and a tagged VLAN with VLAN ID 2001 is configured as the following:

```
Extreme-Netlogin-Extended-VLAN = "U4091;T2001;"
```

VSA 212: Extreme-Security-Profile. This attribute specifies a profile name that the RADIUS server sends to the switch after successful authentication. The switch uses this profile name to run a special type of script called a *profile*. The profile is stored on the switch and can be used to modify the switch configuration in response to authentication. Profiles are created using the Universal Port feature, which is described in [Chapter 6, “Universal Port.”](#)

The following describes the guidelines for VSA 212:

- This VSA must contain a profile name.
- This VSA can include optional variables for use in profile execution.
- The variable entry format is: `<var1>=<value1>;<var2>=<value2>;...`
- Each profile variable must be separated from the others by a semicolon.

When added to the RADIUS users file, the following example provides to the switch the profile name *p1*, variable *QOS=QP8*, and variable *LOGOFF-PROFILE=P2*:

```
EXTREME-SECURITY-PROFILE= "p1 QOS=\ "QP8\ "; LOGOFF-PROFILE=P2; "
```

Configuring the Dictionary File

Before you can use Extreme Networks VSAs on a RADIUS server, you must define the VSAs. On the FreeRADIUS server, you define the VSAs in the *dictionary* file in the `/etc/raddb` directory. You must define the vendor ID for Extreme Networks, each of the VSAs you plan to use, and the values to send for the VSAs. The following example shows the entries to add to a FreeRADIUS server dictionary file for Extreme Networks VSAs:

```
VENDOR          Extreme          1916

ATTRIBUTE       Extreme-CLI-Authorization    201  integer    Extreme
ATTRIBUTE       Extreme-Shell-Command          202  string     Extreme
ATTRIBUTE       Extreme-Netlogin-Vlan          203  string     Extreme
ATTRIBUTE       Extreme-Netlogin-Url           204  string     Extreme
ATTRIBUTE       Extreme-Netlogin-Url-Desc     205  string     Extreme
ATTRIBUTE       Extreme-Netlogin-Only         206  integer    Extreme
ATTRIBUTE       Extreme-User-Location         208  string     Extreme
ATTRIBUTE       Extreme-Netlogin-Vlan-Tag     209  integer    Extreme
ATTRIBUTE       Extreme-Netlogin-Extended-Vlan 211  string     Extreme
ATTRIBUTE       Extreme-Security-Profile     212  string     Extreme

VALUE           Extreme-CLI-Authorization    Disabled    0
VALUE           Extreme-CLI-Authorization    Enabled     1
VALUE           Extreme-Netlogin-Only         Disabled    0
VALUE           Extreme-Netlogin-Only         Enabled     1

# End of Dictionary
```

The lines that begin with `VALUE` provide the integers that the RADIUS server sends to the switch when the corresponding text is configured in the RADIUS users file. For example, if the `Extreme-CLI-Authorization` attribute is set to `Enabled` for a particular user, the RADIUS server sends the value 1 to the switch (which reduces total bytes transferred). The ExtremeXOS software is designed to interpret the integer values as shown above, so be sure to use these values.

Configuring Command Authorization (RADIUS Profiles)

Command authorization is enabled in the *users* file on a FreeRADIUS server, and configured in the *profiles* file. Additional configuration is required in the *dictionary* file and the *clients* file. Other RADIUS servers might use different file names or a different syntax for configuration, but the basic components for configuring command authorization are the same. The following sections describe the tasks for configuring command authorization:

- [Configuring the Users File on page 886](#)
- [Configuring the Dictionary File on page 887](#)
- [Configuring the Clients File on page 887](#)
- [Configuring the Profiles File on page 887](#)

Configuring the Users File

To enable command authorization for a user, you must modify the *users* file entry for the user by configuring the following attributes:

- Profile-Name=<profileName>
- Extreme-CLI-Authorization = Enabled

The following users file entries show different ways that these attributes are configured, and they serve as an example for review later in this section.

```
user    Password = ""
        Filter-Id = "unlim"

admin   Password = "", Service-Type = Administrative
        Filter-Id = "unlim"

eric    Password = "", Service-Type = Administrative, Profile-Name = ""
        Filter-Id = "unlim"
        Extreme:Extreme-CLI-Authorization = Enabled

albert  Password = "", Service-Type = Administrative, Profile-Name =
"Profile1"
        Filter-Id = "unlim"
        Extreme:Extreme-CLI-Authorization = Enabled

lulu    Password = "", Service-Type = Administrative, Profile-Name =
"Profile1"
        Filter-Id = "unlim"
        Extreme:Extreme-CLI-Authorization = Enabled

gerald  Password = "", Service-Type = Administrative, Profile-Name "Profile2"
        Filter-Id = "unlim"
        Extreme:Extreme-CLI-Authorization = Enabled
```



NOTE

If authorization is enabled without specifying a valid profile, the user is unable to execute any commands.

Configuring the Dictionary File

To support the Extreme-CLI-Authorization VSA in the users file, you must add this VSA and the Extreme Networks Vendor ID to the dictionary file. For more information, see [“Configuring the Dictionary File” on page 885](#).

Configuring the Clients File

The RADIUS clients file lists the RADIUS clients that can access the RADIUS server. For all clients that use RADIUS per-command authentication, you must add the following type to the client file:

```
type:extreme:nas + RAD_RFC + ACCT_RFC
```

Configuring the Profiles File

The following example RADIUS *profiles* file entries show an example configuration for three profiles:

```
PROFILE1 deny
{
enable *, disable ipforwarding
show switch
}

PROFILE2
{
enable *, clear counters
show management
}

PROFILE3 deny
{
create vlan *, configure iproute *, disable *, show fdb
delete *, configure rip add
}
```

The following guidelines apply to the *profiles* file:

- Changes to the profiles file require the RADIUS server to be shutdown and restarted.
- A profile with the `permit on` keywords allows use of only the listed commands.
- A profile with the `deny` keyword allows the use of all commands *except* the listed commands.
- Commands are separated by a comma (,) or return.
- When you create command profiles, you can use an asterisk to indicate any possible ending to any particular command.
- The asterisk cannot be used at the beginning of a command.
- Reserved words for commands are matched exactly to those in the profiles file. Due to the exact match, it is not enough to simply enter “sh” for “show” in the profiles file, the complete word must be used. Commands can still be entered in the switch in partial format.
- When you use per-command authorization, you must ensure that communication between the each switch and the RADIUS servers is not lost. If the only operating RADIUS server crashes while users are logged in, users have full administrative access to the switch until they log out. Using two RADIUS servers and enabling idle timeouts on all switches greatly reduces the chance of a user gaining elevated access due to RADIUS server problems.

Based on the profiles listed in the example above and the users listed in the example in [“Configuring the Users File” on page 886](#), command authorization for this example operates as follows:

- User `eric` is able to log in, but is unable to perform any commands, because he has no valid profile assigned.
- Users `albert` and `lulu` are assigned to `PROFILE1`, which uses the `deny` keyword, so their use of commands is as follows:
 - Cannot use any command starting with `enable`.
 - Cannot use the `disable ipforwarding` command.
 - Cannot use a `show switch` command.
 - Can perform all other commands.
- User `gerald` is assigned to `PROFILE2`, so his use of commands is as follows:
 - Can use any `enable` command, the `clear counters` command, and the `show management` command.
 - Cannot execute any other commands on the switch.

Additional RADIUS Configuration Examples

RADIUS server. This section provides examples and guidelines for the following tasks:

- [Installing and Testing the FreeRADIUS Server on page 888](#)
- [Configuring the FreeRADIUS Server on page 889](#)
- [Configuring the RADIUS-to-LDAP Attribute Mappings on page 890](#)
- [Configuring Additional Attributes Mappings on page 890](#)
- [Modifying the RADIUS Schema on page 891](#)
- [Configuring the Authentication Method for Supplicants on page 891](#)
- [Starting the FreeRADIUS Server on page 892](#)

Installing and Testing the FreeRADIUS Server

RADIUS is a client/server protocol based on UDP. The example presented in this section describes a RADIUS server that is a daemon process running on a Linux server.

The following example shows how to install and test a FreeRADIUS server:

```
tar -zxvf freeradius-1.0.2.tar.gz          (extract with gunzip and tar)
./configure
make
make install                             (run this command as root)
radiusd                                  (start RADIUS server, or...)
radiusd -X                               (start RADIUS server in debug mode)
radtest test test localhost 0 testing123 (test RADIUS server)
```

If `radtest` receives a response, the FreeRADIUS server is up and running.

**NOTE**

RADIUS server software can be obtained from several sources. This solution uses the FreeRADIUS software available on the following URLs: <http://www.freeradius.org> and www.redhat.com. Another free tool, NTRadPing, can be used to test authentication and authorization requests from Windows clients. NTRadPing displays detailed responses such as attribute values sent back from the RADIUS server.

Configuring the FreeRADIUS Server

Configuring the RADIUS server involves configuring the RADIUS server and the RADIUS client (for authentication and authorization).

FreeRADIUS configuration files are usually stored in the `/etc/raddb` folder. The following example demonstrates how to configure the FreeRADIUS server for authentication and LDAP support:

1 Modify the `radiusd.conf` file global settings:

```
log_auth = yes           (log authentication requests to the log file)
log_auth_badpass = no   (don't log passwords if request rejected)
log_auth_goodpass = no  (don't log passwords if request accepted)
```

2 Modify LDAP Settings:

```
modules {
    ldap {
        server = "ldaptest.extremenetworks.com"
        basedn = "o=ldaptestdemo,dc=extremenetworks,dc=com"
        filter = "(cn=%{Stripped-User-Name:-%{User-Name}})"
        base_filter = "(objectclass=radiusprofile)"
        start_tls = no
        dictionary_mapping = "${raddbdir}/ldap.attrmap
        authtype = ldap
        ldap_connections_number = 5
        timeout = 4
    }
    timelimit = 3
    net_timeout = 1
}
```

3 Uncomment LDAP from the authorize section:

```
authorize {
    preprocess
    chap
    mschap
    suffix
    ldap
    eap
    files
}
```

4 Uncomment LDAP from the authenticate section:

```

authenticate {
    Auth-Type PAP {
        pap
    }
    Auth-Type CHAP {
        chap
    }
    Auth-Type MS-CHAP {
        mschap
    }
    unix
        ldap
    eap

```

An Extreme Networks edge switch serves as a network access server (NAS) for workstations and as a RADIUS client for the RADIUS server. RADIUS clients are configured in `/etc/raddb/clients.conf`. There are two ways to configure RADIUS clients. Either group the NAS by IP subnet or list the NAS by host name or IP address.

To configure the RADIUS client using the second method, use the following commands:

```

client 192.168.1.1 {
    secret      = extremel
    shortname   = ldap-demo
}

```

Configuring the RADIUS-to-LDAP Attribute Mappings

Attributes are configured in `/etc/freeradius/ldap.attrmap`. This file maps RADIUS attributes to LDAP attributes. Samba has NT/LM password hashes. Hence, the default mapping for LM-Password and NT-Password must be changed.

To configure attribute mappings, use the following commands:

```

checkItem    User-Password          userPassword
checkItem    LMPassword             sambaLMPassword
checkItem    NTPassword             sambaNTPassword
replyItem    Tunnel-Type            radiusTunnelType
replyItem    Tunnel-Medium-Type     radiusTunnelMediumType
replyItem    Tunnel-Private-Group-Id radiusTunnelPrivateGroupId

```

Configuring Additional Attributes Mappings

Attributes are configured in `/etc/freeradius/ldap.attrmap`:

```

## Attributes for Extreme Networks Vendor-Specific RADIUS
replyItem    Extreme-Security-Profile radiusExtremeSecurityProfile
replyItem    Extreme-Netlogin-Vlan-Tag radiusExtremeNetloginVlanTag
replyItem    Extreme-Netlogin-Extended-Vlan radiusExtremeNetloginExtendedVlan

```

Modifying the RADIUS Schema

Additional attributes for RADIUS must be configured to extend the RADIUS-LDAP-V3.schema under the `/etc/openldap` directory.

Use the following commands to modify the RADIUS schema:

```
attributetype
( 1.3.6.1.4.1.3317.4.3.1.61
  NAME 'radiusExtremeSecurityProfile'
  DESC ''
  EQUALITY caseIgnoreIA5Match
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.26
)

attributetype
( 1.3.6.1.4.1.3317.4.3.1.62
  NAME 'radiusExtremeNetloginVlanTag'
  DESC ''
  EQUALITY caseIgnoreIA5Match
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.26
)

attributetype
( 1.3.6.1.4.1.3317.4.3.1.63
  NAME 'radiusExtremeNetloginExtendedVlan'
  DESC ''
  EQUALITY caseIgnoreIA5Match
  SYNTAX 1.3.6.1.4.1.1466.115.121.1.26
)
```

Configuring the Authentication Method for Supplicants

The authentication method is configured in `/etc/raddb/eap.conf`. The authentication method used by FreeRADIUS is the PEAP (Protected EAP) method. To activate PEAP, a TLS tunnel is required to encrypt communication between supplicant and RADIUS server. This means that server certificates are required.

To configure the authentication method, use the following commands:

```
peap {
    default_eap_type = mschapv2
}

tls {
    private_key_password = whatever
    private_key_file = ${raddbdir}/certs/cert-srv.pem
    certificate_file = ${raddbdir}/certs/cert-srv.pem
    CA_file = ${raddbdir}/certs/demoCA/cacert.pem
    dh_file = ${raddbdir}/certs/dh
    random_file = ${raddbdir}/certs/random
    fragment_size = 1024
    include_length = yes
}
```

Starting the FreeRADIUS Server

To start RADIUS in the foreground with debugging enabled, use the following command:

```
radiusd -X -f
```

Implementation Notes for Specific RADIUS Servers

The following sections provide some implementation notes on specific RADIUS servers:

- [Cistron RADIUS on page 892](#)
- [RSA Ace on page 892](#)
- [Steel-Belted Radius on page 892](#)
- [Microsoft IAS on page 893](#)

Cistron RADIUS

Cistron Radius is a popular server, distributed under GPL. Cistron Radius can be found at:

<http://www.radius.cistron.nl/>

When you configure the Cistron server for use with Extreme switches, you must pay close attention to the users file setup. The Cistron Radius dictionary associates the word Administrative-User with Service-Type value 6, and expects the Service-Type entry to appear alone on one line with a leading tab character.

The following is a user file example for read-write access:

```
adminuser  Auth-Type = System
           Service-Type = Administrative-User,
           Filter-Id = "unlim"
```

RSA Ace

For users of their RSA SecureID® product, RSA offers RADIUS capability as part of their RSA/Ace Server® server software. It is mandatory to configure a matching shared-secret key on the switch and RSA Ace server for successful authentication.

Steel-Belted Radius

For users who have the Steel-Belted Radius (SBR) server from Juniper Networks, it is possible to limit the number of concurrent login sessions using the same user account. This feature allows the use of shared user accounts, but limits the number of simultaneous logins to a defined value. Using this feature requires Steel-Belted Radius for RADIUS authentication and accounting.

To limit the maximum concurrent login sessions under the same user account:

- 1 Configure RADIUS and RADIUS-Accounting on the switch.

The RADIUS and RADIUS-Accounting servers used for this feature must reside on the same physical RADIUS server. Standard RADIUS and RADIUS-Accounting configuration is required as described earlier in this chapter.

2 Modify the SBR vendor.ini file and user accounts.

To configure the SBR server, the file `vendor.ini` must be modified to change the Extreme Networks configuration value of `ignore-ports` to `yes` as shown in the example below:

```
vendor-product      = Extreme Networks
dictionary          = Extreme
ignore-ports       = yes
port-number-usage  = per-port-type
help-id            = 2000
```

After modifying the `vendor.ini` file, the desired user accounts must be configured for the Max-Concurrent connections. Using the SBR Administrator application, enable the check box for `Max-Concurrent connections` and fill in the desired number of maximum sessions.

Microsoft IAS

To use Extreme Networks VSAs with the Internet Authentication Service (IAS) in Microsoft® Windows Server™ 2003, you must first create a *Remote Access Policy* and apply it so that user authentication occurs using a specific authentication type such as EAP-TLS, PEAP, or PAP. The following procedure assumes that the Remote Access Policy has already been created and configured and describes how to define Extreme Networks VSAs in Microsoft IAS:

- 1 Open the IAS administration GUI application. In the left window pane, select the Remote Access Policies section of the tree. In the right window pane, double-click the desired Remote-Access policy name so you can edit it.
- 2 Click the *Edit-Profile* button in the lower-left corner, and then select the *Advanced* tab. If any attributes already appear in the Parameters window, remove them by selecting the attribute and clicking the *Remove* button. When the Parameters window is empty, can proceed to the next step.
- 3 Click the *Add* button, which brings up the *Add Attributes* dialog window.
- 4 Scroll down the displayed list of RADIUS attributes and select the attribute named *Vendor-Specific*. Double-click the *Vendor-Specific* attribute or click the *Add* button. The *Multivalued Attribute Information* dialog box should appear.
- 5 Click the *Add* button, which brings up the *Vendor-Specific Attribute Information* dialog window.
 - a Select the first radio button for *Enter Vendor Code* and enter the Extreme Networks vendor code value of 1916 in the text-box.
 - b Select the second radio button for *Yes, It conforms*.
 - c Verify both settings, and click the *Configure Attribute* button to proceed.
- 6 The *Configure VSA (RFC compliant)* dialog window should now appear. The settings for this dialog-window varies, depending on which product and attribute you wish to use in your network.
 - a In the first text-box enter the Extreme Networks VSA number for the attribute you want to configure (see “[Extreme Networks VSAs](#)” on page 879).
 - b Use the pull-down menu to select the *Attribute format*, which is the same as the attribute Type listed in “[Extreme Networks VSAs](#)” on page 879.



NOTE

For values of format integer you will have to select the type ‘Decimal’ from the pull-down menu.

- c Configure the desired value for the attribute.
- d Once the desired values have been entered, click the *OK* button.

- 7 Click the *OK* button two more times to return to the *Add Attributes* dialog window.
- 8 Select *Close*, and then click *OK* twice to complete the editing of the Remote Access Policy profile.
- 9 To apply the configuration changes, stop and restart the Microsoft IAS service.

After restarting the IAS service, new authentications should correctly return the Extreme Networks VSA after successful authentication. Users who were previously authenticated have to re-authenticate to before the new VSAs apply to them.

If you experience problems with the newly configured VSAs, use the following troubleshooting guidelines:

- 1 If you have multiple IAS Remote Access Policies, verify that the user is being authenticated with the correct policy. Check the IAS System Log events within Microsoft Event Viewer to verify the user is authenticated through the policy where VSA settings are configured.
- 2 Check whether the VSA configuration performed above is correct. A mismatch in any of the VSA settings could cause authentication or VSA failure.
- 3 Verify that attributes such as VLAN tag or VLAN name correctly match the configuration of your ExtremeXOS switch and overall network topology. Invalid, or incorrect values returned in the VSA could prevent authenticated users from accessing network resources.

Setting Up Open LDAP

To integrate an ExtremeXOS switch in an LDAP environment, a RADIUS server must be configured to communicate with the LDAP database.

The following components are required to install the access control solution:

- Linux server with Linux Red Hat 4.0
- FREERADIUS 1.1.x
- OpenLDAP 2.3.x
- Extreme Networks switches
- Windows XP clients

To configure Universal Port for use in an LDAP environment, use the following procedure:

- 1 Install and configure a RADIUS server on an existing Linux server as described in [“Installing and Testing the FreeRADIUS Server” on page 888](#).
- 2 Install and configure OpenLDAP as described later in this section.
- 3 Add vendor specific attributes to the RADIUS and LDAP servers as described in [“Installing and Testing the FreeRADIUS Server” on page 888](#) and later in this section.
- 4 Configure the edge switches as described in this guide.
- 5 Configure each supplicant as described in [“Configuring a Windows XP Supplicant for 802.1x Authentication” on page 899](#).

For complete instructions on setting up an LDAP server, see the product documentation for the LDAP server. This section provides examples and guidelines for the following tasks:

- [Installing OpenLDAP on page 895](#)
- [Configuring OpenLDAP on page 895](#)
- [Configuring slapd for Startup on page 895](#)
- [Adding New Schemas on page 896](#)

- [Populating LDAP Database with Organization and User Entries on page 896](#)
- [Restarting the LDAP Server on page 897](#)
- [LDAP Configuration Example on page 897](#)

Installing OpenLDAP

OpenLDAP software is an open source implementation of Lightweight Directory Access Protocol and can be obtained from the site: <http://www.openldap.org>.

To install OpenLDAP packages:

- 1 Verify the Red Hat Linux installed releases. The release number is stored in the `/etc/redhat-release` file.
- 2 Verify the version of OpenLDAP currently installed by entering the command `rpm -qa | grep openldap` at the Linux prompt.

```
# rpm -qa |grep openldap
openldap-2.3.xx-x
openldap-clients-2.3.xx-x
openldap-servers-2.3.xx-x
```

- 3 If you have a default Red Hat Linux installation, there is at least one OpenLDAP Red Hat Package Manager (RPM) installed.

The LDAP RPMs can be found on the Red Hat CD or downloaded from one of the following RPM download sources:

- www.rpmfind.net and search for *openldap* and select the RPM based on the distribution
- www.redhat.com and select Download, and then search for *openldap*

- 4 After downloading the RPMs to the Linux server, change to the download directory and start the installation using the `rpm` command:

```
# rpm -ivh openldap*
```

- 5 Verify that the OpenLDAP RPMs have been installed with the `rpm -qa | grep openldap` command at the Linux prompt.

```
# rpm -qa | grep openldap
openldap-2.3.xx-x
openldap-clients-2.3.xx-x
openldap-servers-2.3.xx-x
```

Configuring OpenLDAP

Once the build is complete, the `slapd` and `slurpd` daemons are located in `/usr/local/libexec`. The config files are in `/etc/openldap` and ready to start the main server daemon, `slapd`.

Configuring slapd for Startup

Before you start `slapd`, edit `/etc/openldap/slapd.conf` to include the location to store the data and details on who is allowed to access the data. The following configuration changes need to be made:

- Change the suffix
- Change the rootDN
- Use `slappasswd` to generate rootpw

- Add rootpw entry

Use the following commands to configure `slapd` for startup:

```
database (use default)
suffix "dc=xxxxxx,dc=org"
rootdn "cn=xxxx,dc=xxxxxx,dc=org"
rootpw {SSHA}c5Pem01KWqz0254r4rnFVmxKA/evs4Hu
directory /var/lib/ldap
allow bind_v2
pidfile /var/run/slapd.pid
```

Adding New Schemas

The RADIUS schema and Samba schema for PEAP authentication must be included into the `slapd.conf` file. After modifying the file, the LDAP server must be restarted to load the new schemas.

Use the following commands to add new schemas:

```
cp /usr/share/doc/freeradius-1.0.1/RADIUS-LDAPv3.schema /etc/openldap/schema/
cp /usr/share/doc/samba-3.0.10/LDAP/samba.schema /etc/openldap/schema
```

Use the following commands to modify `slapd.conf`:

```
include/etc/openldap/schema/RADIUS-LDAPv3.schema
include/etc/openldap/schema/samba.schema
```

Populating LDAP Database with Organization and User Entries

Use the following commands to make the user entry in the LDAP directory (`slapd.conf`):

```
dn: uid=newperson3,o=ldaptestdemo,dc=extremenetworks,dc=com
objectClass: top
objectClass: person
objectClass: radiusprofile << Defined in the RADIUS-LDAPv3 schema
objectClass: sambaSamAccount
sn: ldaptestdemo
uid: newperson3 <<< This username given in the Odyssey client
cn: newperson3
radiusTunnelMediumType: IEEE-802
radiusTunnelType: VLAN
radiusTunnelPrivateGroupId: 2 <<< Value of the VLAN tag
sambaNTPassword: A3A685F89364D4A5182B028FBE79AC38
sambaLMPassword: C23413A8A1E7665FC2265B23734E0DAC
userPassword:: e1NIQX00MXZzNXNYbTRPaHNwUjBFUU9raWdxblDySW89
sambaSID: S-1-0-0-28976
```

The Samba-related attributes can be populated in the LDAP server already if there is an LDAP-enabled Samba infrastructure in place.



NOTE

If the Samba related entries are not present, then the values for `sambaNTPassword` and `sambaNMPPassword` can be created by running the `mkntpwd` command.

```
cd /usr/share/doc/samba-3.0.10/LDAP/smbldap-tools/mkntpwd
make
./mkntpwd -L <password>    (provides value for sambaLMPassword attribute)
./mkntpwd -N <password>    (provides value for sambaNTPassword attribute)
```

Restarting the LDAP Server

Use the following syntax to stop and start LDAP services:

```
service ldap restart
```

For phone authentication (which uses EAP based md5 authentication), the password is stored in clear text in the UserPassword field for the phone entries in LDAP.

LDAP Configuration Example

This configuration example is for Summit X450e switches, but can also be used for other Extreme switches that support 802.1x.

Use the following commands to activate the switch for 802.1X port-based authentication:

```
Create vlan voice
Create vlan data
Create vlan ldap
Configure voice tag 10
Configure data tag 20
Configure ldap ipaddress 192.168.1.1/24
Enable ipforwarding

Create vlan nvlan
En netlogin dot1x
En netlogin port 13-24 dot1x
configure radius netlogin primary server 192.168.1.2 1812 client-ip 192.168.1.1 vr VR-Default
configure radius netlogin primary shared-secret extremel
enable radius netlogin
enable netlogin dot1x
```

Configure the ports to run a script when a user is authenticated through RADIUS and LDAP:

```
configure upm event user-authenticate profile a-avaya ports 1-23
LDAP UID entries:
```

In the LDAP phone UID entry in the *users* file, use the following attribute to specify a profile to run on the switch:

```
Extreme-Security-Profile
```

To add the port as tagged in the *voice* VLAN, use the following attribute in the *users* file:

```
Extreme-Netlogin-Extended-Vlan = TVoice (use UData for a PC)
```

**NOTE**

It depends on the end-station to determine the fields required for authentication; XP uses EAP-PEAP and must have encrypted fields for the UID password. Avaya phones authenticate with MD-5 and must have an unencrypted field in LDAP.

Scripts. The following *a-avaya* script tells the phone to configure itself in the voice VLAN, and to send tagged frames. The script also informs the phone of the file server and call server:

```
create upm profile a-avaya
create log message Starting_UPM_Script_AUTH-AVAYA
set var callServer 10.147.12.12
set var fileServer 10.147.10.3
set var voiceVlan voice
set var CleanupProfile CleanPort
set var sendTraps false
#
create log message Starting_UPM_AUTH-AVAYA_Port_${EVENT}.USER_PORT
#*****
# adds the detected port to the device "unauthenticated" profile port list
#*****
create log message Updating_Unauthenticated_Port_List_Port_${EVENT}.USER_PORT
#configure upm event user-unauthenticated profile CleanupProfile ports
${EVENT}.USER_PORT
#*****
# Configure the LLDP options that the phone needs
#*****
configure lldp port ${EVENT}.USER_PORT advertise vendor-specific dot1 vlan-name vlan
${EVENT}.USER_PORT

configure lldp port ${EVENT}.USER_PORT advertise vendor-specific avaya-extreme call-
server ${callServer}
configure lldp port ${EVENT}.USER_PORT advertise vendor-specific avaya-extreme file-
server ${fileServer}
configure lldp port ${EVENT}.USER_PORT advertise vendor-specific avaya-extreme dot1q-
framing tagged
configure lldp port ${EVENT}.USER_PORT advertise vendor-specific med capabilities
#configure lldp port ${EVENT}.USER_PORT advertise vendor-specific med policy application
voice vlan ${voiceVlan} dscp 46
# If port is PoE capable, uncomment the following lines
#*****
# Configure the POE limits for the port based on the phone requirement
#*****
configure lldp port ${EVENT}.USER_PORT advertise vendor-specific med power-via-mdi
#configure inline-power operator-limit ${EVENT}.DEVICE_POWER ports ${EVENT}.USER_PORT
create log message UPM_Script_A-AVAYA_Finished_Port_${EVENT}.USER_PORT
```

**NOTE**

Parts of the scripts make use of the QP8 profile. This is NOT recommended because the QP8 profile is used by EAPS. For voice, use QP7 for QOS.

**NOTE**

This script uses tagging for the phone and the ports for the voice VLAN. This is NOT necessary; use multiple supplicant and use untagged for the phones.

Configuring a Windows XP Supplicant for 802.1x Authentication

For complete instructions on setting up a Windows XP supplicant, see the product documentation for Microsoft Windows XP. This section provides an overview procedure for configuring a Windows XP supplicant.

**NOTE**

For enhanced security, install the FreeRADIUS server CA certificate (the CA that signed the certificate installed in `eap.conf`).

To configure the supplicant:

- 1 Open the network configuration panel and select the network card and enter the properties.
- 2 Click the Authentication tab, and the Authentication dialog appears.
- 3 Enable 802.1x and disable authenticate as computer. Choose EAP type of Protected EAP, then click Properties.
- 4 Unselect the Validate server certificate and select `eap-mschapv2` as the authentication method. Click Configure.
- 5 Select or unselect the check box depending on whether you want to use the logon name and password, then click OK.

Hypertext Transfer Protocol

The Hypertext Transfer Protocol (HTTP) is a set of rules for transferring and exchanging information (data, voice, images, and so on) on the World Wide Web. HTTP is based on a request-response model. An HTTP client initiates requests by establishing a TCP connection to a port on a remote host (port 80 by default). An HTTP server listening on that port waits for and then responds to the request; in many instances, the client is requesting a specific URL or IP address. Upon receiving a request, the destination server sends back the associated file or files and then closes the connection.

The web server in ExtremeXOS allows HTTP clients to access the switch on port 80 (by default) as well as the network login page without additional encryption or security measures. For information about secure HTTP transmission, including Secure Socket Layer (SSL), see [“Secure Socket Layer” on page 908](#).

By default, HTTP is enabled on the switch. If you disabled HTTP access, you can re-enable HTTP access on the default port (80) using the following command:

```
enable web http
```

To disable HTTP, use the following command:

```
disable web http
```

Secure Shell 2

Secure Shell 2 (SSH2) is a feature of the ExtremeXOS software that allows you to encrypt session data between a network administrator using SSH2 client software and the switch or to send encrypted data from the switch to an SSH2 client on a remote system. Configuration, image, public key, and policy files can be transferred to the switch using the Secure Copy Protocol 2 (SCP2) or the Secure File Transfer Protocol (SFTP).

The ExtremeXOS SSH2 switch application works with the following clients: Putty, SSH2 (version 2.x or later) from SSH Communication Security, and OpenSSH (version 2.5 or later). OpenSSH uses the RCP protocol, which has been disabled in the ExtremeXOS software for security reasons. Consequently, OpenSSH SCP does not work with the ExtremeXOS SSH implementation. You can use OpenSSH SFTP instead.

The section describes the following topics:

- [Enabling SSH2 for Inbound Switch Access on page 900](#)
- [Using ACLs to Control SSH2 Access on page 903](#)
- [Using SCP2 from an External SSH2 Client on page 905](#)
- [Understanding the SSH2 Client Functions on the Switch on page 906](#)
- [Using SFTP from an External SSH2 Client on page 906](#)

Enabling SSH2 for Inbound Switch Access

SSH2 functionality is not present in the base ExtremeXOS software image, but is available as an additional, installable module. Before you can access any SSH2 commands, you must install this additional software module. Without the software module, the commands do not appear on the command line. To install the software module, see the instructions in [Appendix B, “Software Upgrade and Boot Options.”](#)



NOTE

Do not terminate the SSH process (`exsshd`) that was installed since the last reboot unless you have saved your configuration. If you have installed a software module and you terminate the newly installed process without saving your configuration, your module may not be loaded when you attempt to restart the process with the `start process` command.

Because SSH2 is currently under U.S. export restrictions, you must first obtain and install the `ssh.xmod` software module from Extreme Networks before you can enable SSH2.

You must enable SSH2 on the switch before you can connect to the switch using an external SSH2 client. Enabling SSH2 involves two steps:

- Generating or specifying an authentication key for the SSH2 sessions.
- Enabling SSH2 access by specifying a TCP port to be used for communication and specifying on which virtual router SSH2 is enabled.

After it has enabled, by default, SSH2 uses TCP port 22 and is available on all virtual routers.

Standard Key Authentication

An authentication key must be generated before the switch can accept incoming SSH2 sessions. This can be done automatically by the switch, or you can enter a previously generated key. To have the key generated by the switch, use the following command:

```
configure ssh2 key
```

The key generation process can take up to ten minutes. After the key has been generated, you should save your configuration to preserve the key.

To use a key that has been previously created, use the following command:

```
configure ssh2 key {pregenerated}
```

The switch prompts you to enter the pregenerated key.



NOTE

The pregenerated key must be one that was generated by the switch. To get such key, you can use the command `show ssh2 private-key` to display the key on the console. Copy the key to a text editor and remove the carriage return/line feeds from the key. Finally, copy and paste the key into the command line. The key must be entered as one line.

The key generation process generates the SSH2 private host key. The SSH2 public host key is derived from the private host key and is automatically transmitted to the SSH2 client at the beginning of an SSH2 session.

User Key Based Authentication

Public-Key authentication is an alternative method to password authentication that SSH uses to verify identity. You can generate a key pair consisting of a private key and a public-key. The public-key is used by the ExtremeXOS SSH server to authenticate the user.

In ExtremeXOS, user public keys are stored in the switch's configuration file; these keys are then associated (or *bound*) to a user. The keys are configured on the switch in one of two ways:

- By copying the key to the switch using `scp2/sftp2` with the switch acting as the server
- By configuring the key using the CLI

RSA and DSA encryption keys are both supported.

The public key can be loaded onto the switch using SCP or SFTP, where the switch is the server. The administrator can do this by using the SCP2 or SFTP2 client software to connect to and copy the key file to the switch. The public key file must have the extension `ssh`; for example `id_dsa_2048.ssh`. When the `.ssh` file is copied to the switch, the key is loaded into the memory. The loaded public keys are saved to the configuration file (`*.cfg`) when the `save` command is issued via the CLI.

The key name is derived from the file name. For example, the key name for the file `id_dsa_2048.ssh` will be `id_dsa_2048`.

The key is associated with a user either implicitly, by pre-pending the user name to the file or explicitly, using the CLI.

In order for a key to be bound or associated to a user, the user must be known. In other words, that user must have an entry in the local database on the switch. Once the user is authenticated the user's rights (read-only or read/write) are obtained from the database.

The key can be associated with a user by pre-pending the user name to the file name. For example, `admin.id_dsa_2048.ssh`.

If the user specified in the filename does not exist on the switch, the key is still accepted, but will not be associated to any user. Once the user is added, the key can be associated with the user via the CLI. If the user name is not pre-pended to the filename, the key is accepted by the switch but is not associated with any user. The key can be then be associated with the user via the CLI.

You can also enter or paste the key using the CLI. There cannot be any carriage returns or new lines in the key. See the appropriate reference page in the *ExtremeXOS Command Reference Guide* for additional details.

The host and user public keys can be written to a file in the config directory using the `create sshd2 key-file` command. This enables the administrator to copy the public key to an outside server.

Enabling SSH2

To enable SSH2, use the following command:

```
enable ssh2 {access-profile [<access_profile> | none]} {port <tcp_port_number>} {vr  
[<vr_name> | all | default]}
```

You can also specify a TCP port number to be used for SSH2 communication. By default the TCP port number is 22. The switch accepts IPv6 connections.

Before you initiate a session from an SSH2 client, ensure that the client is configured for any non-default access list or TCP port information that you have configured on the switch. After these tasks are accomplished, you may establish an SSH2-encrypted session with the switch. Clients must have a valid user name and password on the switch in order to log in to the switch after the SSH2 session has been established.

Up to eight active SSH2 sessions can run on the switch concurrently. If you enable the idle timer using the `enable idletimeout` command, the SSH2 connection times out after 20 minutes of inactivity by default. If you disable the idle timer using the `disable idletimeout` command, the SSH2 connection times out after 61 minutes of inactivity. If a connection to an SSH2 session is lost inadvertently, the switch terminates the session within 61 minutes.

For additional information on the SSH protocol refer to Federal Information Processing Standards Publication (FIPSPUB) 186, Digital Signature Standard, 18 May 1994. This can be download from: <ftp://ftp.cs.hut.fi/pub/ssh>. General technical information is also available from:

<http://www.ssh.fi>

Viewing SSH2 Information

To view the status of SSH2 sessions on the switch, use the following command:

```
show management
```

The `show management` command displays information about the switch including the enable/disable state for SSH2 sessions and whether a valid key is present.

Using ACLs to Control SSH2 Access

You can restrict SSH2 access by creating and implementing an ACL policy. You configure an ACL policy to permit or deny a specific list of IP addresses and subnet masks for the SSH2 port.

The two methods to load ACL policies to the switch are:

- Use the `edit policy` command to launch a VI-like editor on the switch. You can create the policy directly on the switch.
- Use the `tftp` command to transfer a policy that you created using a text editor on another system to the switch.

For more information about creating and implementing ACLs and policies, see [Chapter 17, “Policy Manager,”](#) and [Chapter 18, “ACLs.”](#)

Sample SSH2 Policies

The following are sample policies that you can apply to restrict SSH2 access.

In the following example named `MyAccessProfile.pol`, the switch permits connections from the subnet `10.203.133.0/24` and denies connections from all other addresses:

```
MyAccessProfile.pol

Entry AllowTheseSubnets {
if {
source-address 10.203.133.0 /24;
}
then
{
permit;
}
}
```

In the following example named `MyAccessProfile.pol`, the switch permits connections from the subnets `10.203.133.0/24` or `10.203.135.0/24` and denies connections from all other addresses:

```
MyAccessProfile.pol
Entry AllowTheseSubnets {
if match any {
source-address 10.203.133.0 /24;
source-address 10.203.135.0 /24;
}
then
{
permit;
}
}
```

In the following example named `MyAccessProfile_2.pol`, the switch does not permit connections from the subnet `10.203.133.0/24` but accepts connections from all other addresses:

```
MyAccessProfile_2.pol
Entry dontAllowTheseSubnets {
if {
source-address 10.203.133.0 /24;
}
then
{
deny;
}
}

Entry AllowTheRest {
If {
; #none specified
}
then
{
permit;
}
}
```

In the following example named `MyAccessProfile_2.pol`, the switch does not permit connections from the subnets `10.203.133.0/24` or `10.203.135.0/24` but accepts connections from all other addresses:

```
MyAccessProfile_2.pol
Entry dontAllowTheseSubnets {
if match any {
source-address 10.203.133.0 /24;
source-address 10.203.135.0 /24
}
then
{
deny;
}
}

Entry AllowTheRest {
If {
; #none specified
}
then
{
permit;
}
}
```

Configuring SSH2 to Use ACL Policies

This section assumes that you have already loaded the policy on the switch. For more information about creating and implementing ACLs and policies, see [Chapter 17, “Policy Manager,”](#) and [Chapter 18, “ACLs.”](#)

To configure SSH2 to use an ACL policy to restrict access, use the following command:

```
enable ssh2 {access-profile [<access_profile> | none]} {port <tcp_port_number>} {vr
 [<vr_name> | all | default]}
```

Use the `none` option to remove a previously configured ACL.

In the ACL policy file for SSH2, the `source-address` field is the only supported match condition. Any other match conditions are ignored

Using SCP2 from an External SSH2 Client

In ExtremeXOS, the SCP2 protocol is supported for transferring configuration, image and public key policy files to the switch from the SCP2 client.

The user must have administrator-level access to the switch. The switch can be specified by its switch name or IP address.

ExtremeXOS only allows SCP2 to transfer to the switch files named as follows:

- *.cfg—ExtremeXOS configuration files
- *.pol—ExtremeXOS policy files
- *.xos—ExtremeXOS core image files
- *.xmod—ExtremeXOS modular package files
- *.ssh—Public key files

In the following examples, you are using a Linux system to move files to and from the switch at 192.168.0.120, using the switch administrator account `admin`. You are logged into your Linux system as `user`:

To transfer the primary configuration file from the switch to your current Linux directory using SCP2, use the following command:

```
[user@linux-server]# scp2 admin@192.168.0.120:primary.cfg primary.cfg
```

To copy the policy filename `test.pol` from your Linux system to the switch, use the following command:

```
[user@linux-server]# scp2 test.pol admin@192.168.0.120:test.pol
```

To copy the image file `test.xos` from your Linux system to the switch, use the following command:

```
[user@linux-server]# scp2 test.xos admin@192.168.0.120:test.xos
```

Now you can use the command `install image test.xos` to install the image in the switch.

To copy the SSH image file `test.xmod` from your Linux system to the switch, use the following command:

```
[user@linux-server]# scp2 test.xmod admin@192.168.0.120:test.xmod
```

Now you can use the command `install image test.xmod` to install the image in the switch.

To load the public key `id_rsa.pub` from your Linux system to the switch, use the following command:

```
[user@linux-server]# scp2 id_rsa.pub admin@192.168.0.120:test.ssh
```

This command loads the key into memory, which can be viewed with the command `show sshd2 user-key`.

Understanding the SSH2 Client Functions on the Switch

An Extreme Networks switch can function as an SSH2 client. This means you can connect from the switch to a remote device running an SSH2 server and send commands to that device. You can also use SCP2 to transfer files to and from the remote device.

You do not need to enable SSH2 or generate an authentication key to use the SSH2 and SCP2 commands from the ExtremeXOS CLI.



NOTE

User-created VRs are supported only on the platforms listed for this feature in [Appendix A, "Feature License Requirements."](#)

To send commands to a remote system using SSH2, use the following command:

```
ssh2 {cipher [3des | blowfish]} {port <portnum>} {compression [on | off]} {user <username>} {<username>@} [<host> | <ipaddress>] {<remote command>} {vr <vr_name>}
```

The remote commands can be any command acceptable by the remote system. You can specify the login user name as a separate argument or as part of the user@host specification. If the login user name for the remote system is the same as your user name on the switch, you can omit the username parameter entirely.

For example, to obtain a directory listing from a remote Linux system with IP address 10.10.0.2 using SSH2, enter the following command:

```
ssh2 admin@10.10.0.2 ls
```

To initiate a file copy from a remote system to the switch using SCP2, use the following command:

```
scp2 {vr <vr_name>} {cipher [3des | blowfish]} {port <portnum>} <user>@ [<hostname> | <ipaddress>]:<remote_file> <local_file>
```

For example, to copy the configuration file test.cfg on host system1 to the switch, enter the following command:

```
scp2 admin@system1:test.cfg localtest.cfg
```

To initiate a file copy to a remote system from the switch using SCP2, use the following command:

```
scp2 {vr <vr_name>} {cipher [3des | blowfish]} {port <portnum>} <local_file> <user>@ [<hostname> | <ipaddress>]:<remote_file>
```

For example, to copy the configuration file engineering.cfg from the switch to host system1, enter the following command:

```
scp2 engineering.cfg admin@system1:engineering.cfg
```

Using SFTP from an External SSH2 Client

The SFTP protocol is supported for transferring configuration, and policy files to the switch from the SFTP client. You must have administrator-level access to the switch. The switch can be specified by its switch name or IP address.

ExtremeXOS requires that SFTP transfer to the switch files named as follows:

- *.cfg—ExtremeXOS configuration files
- *.pol—ExtremeXOS policy files
- *.xos—ExtremeXOS core image file
- *.xmod—ExtremeXOS modular package file
- *.ssh—Public key files

In the following examples, you are using a Linux system to move files to and from the switch at 192.168.0.120, using the switch administrator account *admin*. You are logged into your Linux system as account *user*.

To transfer the primary configuration file from the switch to your current Linux directory using SCP2, use the following command:

```
[user@linux-server]# sftp admin@192.168.0.120
password: <Enter password>
sftp> put primary.cfg
```

To copy the policy filename *test.pol* from your Linux system to the switch, use the following command:

```
[user@linux-server]# sftp admin@192.168.0.120
password: <Enter password>
sftp> put test.pol
```

To copy the image file *test.xos* from your Linux system to the switch, use the following command:

```
[user@linux-server]# sftp admin@192.168.0.120
password: <Enter password>
sftp> put test.xos
```

To copy the SSH image file *test-ssh.xmod* from your Linux system to the switch, use the following command:

```
[user@linux-server]# sftp admin@192.168.0.120
password: <Enter password>
sftp> put test-ssh.xmod
```

To load the public keyed *rsa.pub* from your Linux system to the switch, use the following command:

```
[user@linux-server]# sftp admin@192.168.0.120
password: <Enter password>
sftp> put id_rsa.pub id_rsa.ssh
```

For image file transfers, only one image file at a time can be available for installation. In other words, if *test.xos* and *test-ssh.xmod* both need to be installed, you must follow these steps:

- 1 Transfer *test.xos* into the switch using *scp/sftp*
- 2 Install the *test.xos* image using the "install image" command
- 3 Transfer *test-ssh.xmod* into the switch using *scp/sftp*
- 4 Install the *test-ssh.xmod* modular package file using "install image" command.

For image file transfers using SFTP or SCP (with the switch acting as the server), once the image is copied to the switch, validation of image is done by the switch, as indicated by the following log message:

```
<Info:AAA.LogSsh> Validating Image file, this could take approximately 30 seconds..
test.xos
```

You must receive the following log message before you can proceed with the installation of the image:

```
<Info:AAA.LogSsh> Image file test-ssh.xmod successfully validated
```

In stacking switches, you must receive the following log message from all slots before proceeding with the installation. For example, in a four-switch stack, the installation can be proceed only after the following log messages are received:

```
04/19/2007 17:41:09.71 <Info:AAA.LogSsh> Slot-1: Sent file "test.xos" info to backup
04/19/2007 17:41:09.71 <Info:AAA.LogSsh> Slot-1: Sent file "test.xos" info to standby
slot 3
04/19/2007 17:41:09.71 <Info:AAA.LogSsh> Slot-1: Sent file "test-12.0.0.13.xos" info
to standby slot 4
```

Secure Socket Layer

Secure Socket Layer (SSLv3) is a feature of ExtremeXOS that allows you to authenticate and encrypt data over an SSL connection to provide secure communication. The existing web server in ExtremeXOS allows HTTP clients to access the network login page. By using HTTPS on the web server, clients securely access the network login page using an HTTPS enabled web browser. Since SSL encrypts the data exchanged between the server and the client, you protect your data, including network login credentials, from unwanted exposure.

HTTPS access is provided through SSL and the Transport Layer Security (TLS1.0). These protocols enable clients to verify the authenticity of the server to which they are connecting, thereby ensuring that users are not compromised by intruders.

Similar to SSH2, before you can use any SSL commands, you must first download and install the separate Extreme Networks SSH software module (ssh.xmod). This additional module allows you to configure both SSH2 and SSL on the switch. SSL is packaged with the SSH module; therefore, if you do not install the module, you are unable to configure SSL. If you try to execute SSL commands without installing the module first, the switch notifies you to download and install the module. To install the module, see the instructions in [Appendix B, “Software Upgrade and Boot Options.”](#)

You must upload or generate a certificate for SSL server use. Before you can upload a certificate, you must purchase and obtain an SSL certificate from an Internet security vendor. The following security algorithms are supported:

- RSA for public key cryptography (generation of certificate and public-private key pair, certificate signing). RSA key size between 1024 and 4096 bits.
- Symmetric ciphers (for data encryption): RC4, DES, and 3DES.
- Message Authentication Code (MAC) algorithms: MD5 and SHA.

The Converged Network Analyzer (CNA) Agent requires SSL to encrypt communication between the CNA Agent and the CNA Server. For more information about the CNA Agent, see [Appendix C, “CNA Agent.”](#)

This section describes the following topics:

- [Enabling and Disabling SSL on page 909](#)
- [Creating Certificates and Private Keys on page 909](#)
- [Displaying SSL Information on page 911](#)

Enabling and Disabling SSL

This section describes how to enable and disable SSL on your switch.



NOTE

Before ExtremeXOS 11.2, the Extreme Networks SSH module did not include SSL. To use SSL for secure HTTPS web-based login, you must upgrade your core software image to ExtremeXOS 11.2 or later, install the SSH module that works in concert with that core software image, and reboot the switch.

Keep in mind the following guidelines when using SSL:

- To use SSL with web-based login (secure HTTP access, HTTPS) you must specify the HTTPS protocol when configuring the redirect URL.
- If you are downloading the SSH module for the first time and want to immediately use SSL for secure HTTPS web-based login, restart the `thttpd` process after installing the SSH module. For more detailed information about activating the SSH module, see [“Guidelines for Activating SSL” in Appendix B, “Software Upgrade and Boot Options.”](#)

To enable SSL and allow secure HTTP (HTTPS) access on the default port (443), use the following command:

```
enable web https
```

To disable SSL and HTTPS, use the following command:

```
disable web https
```

Creating Certificates and Private Keys

When you generate a certificate, the certificate is stored in the configuration file, and the private key is stored in the EEPROM. The certificate generated is in PEM format.

To create a self-signed certificate and private key that can be saved in the EEPROM, use the following command:

```
configure ssl certificate privkeylen <length> country <code> organization <org_name>  
common-name <name>
```

Make sure to specify the following:

- Country code (maximum size of 2 characters)
- Organization name (maximum size of 64 characters)
- Common name (maximum size of 64)

Any existing certificate and private key is overwritten.

The size of the certificate depends on the RSA key length (`privkeylen`) and the length of the other parameters (`country`, `organization` name, and so forth) supplied by the user. If the RSA key length is 1024, then the certificate is approximately 1 kb. For an RSA key length of 4096, the certificate length is approximately 2 kb, and the private key length is approximately 3 kb.

Downloading a Certificate Key from a TFTP Server

You can download a certificate key from files stored in a TFTP server. If the operation is successful, any existing certificate is overwritten. After a successful download, the software attempts to match the public key in the certificate against the private key stored. If the private and public keys do not match, the switch displays a warning message similar to the following: `Warning: The Private Key does not match with the Public Key in the certificate.` This warning acts as a reminder to also download the private key.

Downloaded certificates and keys are not saved across switch reboots unless you save your current switch configuration. After you use the `save` command, the downloaded certificate is stored in the configuration file and the private key is stored in the EEPROM.

To download a certificate key from files stored in a TFTP server, use the following command:

```
download ssl <ip_address> certificate <cert file>
```



NOTE

For security measures, you can only download a certificate key in the VR-Mgmt virtual router.

To see whether the private key matches with the public key stored in the certificate, use the following command:

```
show ssl {detail}
```

This command also displays:

- HTTPS port configured. This is the port on which the clients will connect.
- Length of the RSA key (the number of bits used to generate the private key).
- Basic information about the stored certificate.

Downloading a Private Key from a TFTP Server

To download a private key from files stored in a TFTP server, use the following command:

```
download ssl <ip_address> privkey <key file>
```

If the operation is successful, the existing private key is overwritten. After the download is successful, a check is performed to find out whether the private key downloaded matches the public key stored in the certificate. If the private and public keys do not match, the switch displays a warning message similar to the following: `Warning: The Private Key does not match with the Public Key in the certificate.` This warning acts as a reminder to also download the corresponding certificate.

For security reasons, when downloading private keys, Extreme Networks recommends obtaining a pre-generated key rather than downloading a private key from a TFTP server. See [“Configuring Pregenerated Certificates and Keys” on page 911](#) for more information.

Downloaded certificates and keys are not saved across switch reboots unless you save your current switch configuration. After you use the `save` command, the downloaded certificate is stored in the configuration file and the private key is stored in the EEPROM.

Configuring Pregenerated Certificates and Keys

To get the pregenerated certificate from the user, use the following command:

```
configure ssl certificate pregenerated
```

You can copy and paste the certificate into the command line followed by a blank line to end the command.

This command is also used when downloading or uploading the configuration. Do not modify the certificate stored in the uploaded configuration file because the certificate is signed using the issuer's private key.

The certificate and private key file should be in PEM format and generated using RSA as the cryptography algorithm.

To get the pregenerated private key from the user, use the following command:

```
configure ssl privkey pregenerated
```

You can copy and paste the key into the command line followed by a blank line to end the command.

This command is also used when downloading or uploading the configuration. The private key is stored in the EEPROM.

The certificate and private key file should be in PEM format and generated using RSA as the cryptography algorithm.

Displaying SSL Information

To display whether the switch has a valid private and public key pair and the state of HTTPS access, use the following command:

```
show ssl
```


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CHAPTER

CLEAR-Flow

This chapter includes the following sections:

- [Overview on page 913](#)
- [Configuring CLEAR-Flow on page 914](#)
- [Adding CLEAR-Flow Rules to ACLs on page 915](#)
- [CLEAR-Flow Rule Examples on page 927](#)

Overview

CLEAR-Flow is a broad framework for implementing security, monitoring, and anomaly detection in ExtremeXOS software. Instead of simply looking at the source and destination of traffic, CLEAR-Flow allows you to specify certain types of traffic that require more attention. After certain criteria for this traffic are met, the switch can either take an immediate, predetermined action, or send a copy of the traffic off-switch for analysis.

CLEAR-Flow is an extension to Access Control Lists (ACLs). You create ACL policy rules to count packets of interest. CLEAR-Flow rules are added to the policy to monitor these ACL counter statistics. The CLEAR-Flow agent monitors the counters for the situations of interest to you and your network. You can monitor the cumulative value of a counter, the change to a counter over a sampling interval, the ratio of two counters, or even the ratio of the changes of two counters over an interval. For example, you can monitor the ratio between TCP SYN and TCP packets. An abnormally large ratio may indicate a SYN attack.

The counters used in CLEAR-Flow are either defined by you in an ACL entry, or can be a predefined counter. See [“Predefined CLEAR-Flow Counters” on page 924](#) for a list and description of these counters.

If the rule conditions are met, the CLEAR-Flow actions configured in the rule are executed. The switch can respond by modifying an ACL that will block, prioritize, or mirror the traffic, executing a set of CLI commands, or sending a report using a SNMP trap or EMS log message.



NOTE

CLEAR-Flow is available on platforms with an Edge, Advanced Edge, or Core license. These include BlackDiamond 8000 a-, c-, e-, xl-, and xm-series modules, BlackDiamond X8 series switches and Sumit X250e, X440, X450a, X450e, X460, X480, X650, and X670 series switches. For more license information, see [Appendix A, “Feature License Requirements.”](#)

CLEAR-Flow is supported only on ingress. Any limitations on a given platform for a regular ACL also hold true for CLEAR-Flow.

Configuring CLEAR-Flow

CLEAR-Flow is an extension to ACLs, so you must be familiar with configuring ACLs before you add CLEAR-Flow rules to your ACL policies. Creating ACLs is described in detail in [Chapter 18, “ACLs”](#). The chapter describes how to create ACL policies, the syntax of an ACL policy file, and how to apply ACL policies to the switch. In this current chapter, you will find information about the CLEAR-Flow rules that you add to ACL policies, including the CLEAR-Flow rules’ syntax and behavior.

After creating the ACLs that contain CLEAR-Flow rules, and after applying the ACLs to the appropriate interface, you enable CLEAR-Flow on the switch. When CLEAR-Flow is enabled, the rules are evaluated by the CLEAR-Flow agent on the switch, and when any rules are triggered, the CLEAR-Flow actions are executed.

To enable CLEAR-Flow, use the following command:

```
enable clear-flow
```

When you disable the CLEAR-Flow agent on the switch, CLEAR-Flow sampling stops, and all rules are left in the current state. To disable CLEAR-Flow, use the following command:

```
disable clear-flow
```



NOTE

Any actions triggered while CLEAR-Flow is enabled will continue when CLEAR-Flow is disabled, unless explicitly stopped.

Displaying CLEAR-Flow Configuration and Activity

To display the state of the CLEAR-Flow agent, any CLEAR-Flow policies on each interface, and the number of CLEAR-Flow rules, use the following command:

```
show clear-flow
```

To display the CLEAR-Flow rules and configuration, use the following command:

```
show clear-flow rule
```

Or to display all the rules, use the following command:

```
show clear-flow rule-all
```

When CLEAR-Flow is enabled, any rules that satisfy the threshold will trigger and take action. To display the CLEAR-Flow rules that have been triggered, use the following command:

```
show clear-flow rule-triggered
```

To display which ACLs have been modified by CLEAR-Flow rules, use the following command:

```
show clear-flow acl-modified
```

Adding CLEAR-Flow Rules to ACLs

As described in the chapter about ACLs, each ACL policy file consists of a number of named entries. Each entry consists of match conditions and actions to take if the entry is matched. CLEAR-Flow builds on the ACL concept to include rules that are periodically checked, and actions to take if a rule is triggered. The CLEAR-Flow entries are similar to the ACL entries.

The syntax of a CLEAR-Flow rule entry is:

```
entry <CLFrulename> {
    if <match-type> { <match-conditions>;
    }
    then {
        <actions>;
    }
}
```

Or you can specify an optional `else` clause:

```
entry <CLFrulename> {
    if <match-type> { <match-conditions>;
    }
    then {
        <actions>;
    } else {
        <actions>;
    }
}
```

In the CLEAR-Flow rule syntax, the `<CLFrulename>` is the name of the rule (maximum of 31 characters). The `<match-type>` specifies whether the rule is triggered when any of the expressions that make up the conditions are true (logical OR), or only when all of the expressions are true (logical AND). The `<match-type>` is an optional element. The `<match-conditions>` specifies the conditions that will trigger the rule, and how often to evaluate the rule. The `<actions>` in the `then` clause is the list of actions to take when the rule is triggered, and the optional `else` clause `<actions>` is the list of actions to take after the rule is triggered, and when the `<match-conditions>` later become false.



NOTE

When you create an ACL policy file that contains CLEAR-Flow rules, the CLEAR-Flow rules do not have any precedence, unlike the ACL entries. Each CLEAR-Flow rule specifies how often it should be evaluated. The order of evaluation depends on the sampling time and when the CLEAR-Flow agent receives the counter statistics. The order of the CLEAR-Flow rules in the policy file does not have any significance.

The rule match type, rule match conditions, and rule actions are discussed in these sections:

- [CLEAR-Flow Rule Match Type on page 916](#)
- [CLEAR-Flow Rule Match Conditions on page 916](#)
- [CLEAR-Flow Rule Actions on page 922](#)

CLEAR-Flow Rule Match Type

The match type is optional. The two possible choices for the match type are:

- match all—All the match expressions must be true for a match to occur. This is the default.
- match any—If any match expression is true, then a match occurs.

CLEAR-Flow Rule Match Conditions

In a CLEAR-Flow rule, the `<match-conditions>` portion consists of one to four expressions, an optional `global-rule` statement, and an optional `period` statement:

```
entry <CLFrulename> {
    if <match-type> { <expression>;
        <expression>;
        <expression>;
        <expression>;
        global-rule;
        period <interval>;
    }
    then {
        <actions>;
    } else {
        <actions>;
    }
}
```

In the following example, the CLEAR-Flow rule `cflow_count_rule_example` will be evaluated every ten seconds. The actions statements will be triggered if the value of counter1 (defined earlier in the ACL policy file) is greater than 1,000,000:

```
entry cflow_count_rule_example {
    if { count counter1 > 1000000 ;
        period 10 ;
    }
    then {
        <actions>;
    }
}
```

The `global-rule` statement is optional and affects how the counters are treated. An ACL that defines counters can be applied to more than one interface. You can specify the `global-rule` statement so that counters are evaluated for all the applied interfaces. For example, if a policy that defines a counter is applied to port 1:1 and 2:1, a CLEAR-Flow rule that used the `global-rule` statement would sum up the counts from both ports. Without the `global-rule` statement, the CLEAR-Flow rule would look at only the counts received on one port at a time.

The `period <interval>` statement is optional and sets the sampling interval, in seconds. This statement specifies how often the rule is evaluated by the CLEAR-Flow agent. If not specified, the default value is 5 seconds.

The five CLEAR-Flow rule expressions are: `count`, `delta`, `ratio`, `delta-ratio`, and `rule`. All of these expressions check the values of counters to evaluate if an action should be taken. The counters are either defined in the ACL entries that are defined on the switch, or are the predefined CLEAR-Flow counters. When you use a counter statement in an ACL, you are defining the counter used by CLEAR-Flow to monitor your system.

The following sections discuss the CLEAR-Flow rule expressions in detail:

- [Count Expression on page 917](#)
- [Delta Expression on page 918](#)
- [Ratio Expression on page 919](#)
- [Delta-Ratio Expression on page 920](#)
- [Rule-True-Count Expression on page 921](#)

Count Expression

A CLEAR-Flow count expression compares a counter with the threshold value. The following is the syntax for a CLEAR-Flow count expression:

```
count <counterName> REL_OPER <countThreshold> ;
hysteresis <hysteresis> ;
```

The value of `<countThreshold>` and `<hysteresis>` can be specified as floating point numbers. The `count` statement specifies how to compare a counter with its threshold. The `<counterName>` is the name of an ACL counter referred to by an ACL rule entry and the `<countThreshold>` is the value compared with the counter. The `REL_OPER` is selected from the relational operators for greater than, greater than or equal to, less than, or less than or equal to (`>`, `>=`, `<`, `<=`).

The `hysteresis <hysteresis>` statement is optional, and sets a hysteresis value for the threshold. After the `count` statement is true, the value of the threshold is adjusted so that a change smaller than the hysteresis value will not cause the statement to become false. For statements using the `REL_OPER >` or `>=`, the hysteresis value is subtracted from the threshold; for `<` or `<=`, the hysteresis value is added to the threshold.

Following is an example of a count expression used in a CLEAR-Flow rule:

```
entry cflow_count_rule_example {
    if { count counter1 > 1000000 ;
        period 10 ;
    }
    then {
        <actions>;
    }
}
```

Actions are discussed in the section, “[CLEAR-Flow Rule Actions](#)” on page 922.

In [Table 100](#) is an example of evaluating the CLEAR-Flow count expression above multiple times. Notice that the rule is not triggered until evaluation 3, when the value of the counter is greater than 1,000,000.

Table 100: Count Expression Evaluation Example

Evaluation	counter1 value	Rule triggered?
1	384625	No
2	769250	No
3	1153875	Yes
4	1538500	Yes

See “[Count Expression Example](#)” on page 927 for a full example of an ACL and a CLEAR-Flow rule using a count expression.

Delta Expression

A CLEAR-Flow delta expression computes the difference from one sample to the next of a counter value. This difference is compared with the threshold value. The following is the syntax for a CLEAR-Flow delta expression:

```
delta <counterName> REL_OPER <countThreshold> ;
hysteresis <hysteresis> ;
```

The value of `<countThreshold>` and `<hysteresis>` can be specified as floating point numbers. The delta expression specifies how to compare the difference in a counter value from one sample to the next with its threshold. The `<counterName>` is the name of an ACL counter referred to by an ACL rule entry and the `<countThreshold>` is the value compared with the difference in the counter from one sample to the next. The `REL_OPER` is selected from the relational operators for greater than, greater than or equal to, less than, or less than or equal to (`>`, `>=`, `<`, `<=`).

The `hysteresis <hysteresis>` statement is optional, and sets a hysteresis value for the threshold. After the delta statement is true, the value of the threshold is adjusted so that a change smaller than the hysteresis value will not cause the statement to become false. For statements using the `REL_OPER >` or `>=`, the hysteresis value is subtracted from the threshold; for `<` or `<=`, the hysteresis value is added to the threshold.

For example, the following delta expression:

```
delta counter1 >= 100 ;
hysteresis 10 ;
```

will only be true after the delta of the counter reaches at least 100. At the time it becomes true, the hysteresis value is subtracted from the threshold (setting the threshold to 90). With the threshold now at 90, the condition would stay true until the delta of the counter becomes less than 90.

If the expression becomes false, the threshold is reset to its original value. You would use the hysteresis value to prevent the expression from vacillating between the true and false states if the difference between the counter values is near the threshold. If the hysteresis value is greater than the threshold value, the hysteresis value will be set to 0.

In [Table 101](#) is an example of evaluating the CLEAR-Flow delta expression above multiple times. Notice that the rule is not triggered until evaluation 4, when the delta value (the change in the counter value from one evaluation to the next) is greater than or equal to 100. After the rule is triggered, it remains triggered until the delta value is less than 90 (the original threshold minus the hysteresis), at evaluation 7. At evaluation 9, the rule is again triggered when the delta reaches 100. The rule will remain triggered until the delta drops below 90.

Table 101: Delta Expression Evaluation Example

Evaluation	counter1 value	Delta value	Rule triggered?
1	397	N/A	No
2	467	70	No
3	547	80	No
4	657	110	Yes
5	757	100	Yes

Table 101: Delta Expression Evaluation Example (Continued)

Evaluation	counter1 value	Delta value	Rule triggered?
6	852	95	Yes
7	932	80	No
8	1031	99	No
9	1131	100	Yes
10	1230	99	Yes

See “[Delta Expression Example](#)” on page 927 for a full example of an ACL and a CLEAR-Flow rule using a delta expression.

Ratio Expression

A CLEAR-Flow ratio expression compares the ratio of two counter values with the threshold value. The following is the syntax for a CLEAR-Flow ratio expression:

```
ratio <counterNameA> <counterNameB> REL_OPER <countThreshold> ;
min-value <min-value> ;
hysteresis <hysteresis> ;
```

The value of `<countThreshold>` and `<hysteresis>` can be specified as floating point numbers, and the ratio is computed as a floating point number. The `ratio` statement specifies how to compare the ratio of two counters with its threshold. The value of `<counterNameA>` is divided by the value of `<counterNameB>`, to compute the ratio. That ratio is compared with the `<countThreshold>`. The `REL_OPER` is selected from the relational operators for greater than, greater than or equal to, less than, or less than or equal to (`>`, `>=`, `<`, `<=`).

The `min-value` statement is optional, and sets a minimum value for the counters. If either counter is less than the minimum value, the expression evaluates to false. If not specified, the minimum value is 1.

The `hysteresis <hysteresis>` statement is optional, and sets a hysteresis value for the threshold. After the `ratio` statement is true, the value of the threshold is adjusted so that a change smaller than the hysteresis value will not cause the statement to become false. For statements using the `REL_OPER >` or `>=`, the hysteresis value is subtracted from the threshold; for `<` or `<=`, the hysteresis value is added to the threshold.

For example, the following ratio expression:

```
ratio counter1 counter2 >= 5 ;
min-value 100;
hysteresis 1 ;
```

is true only after the ratio of the counters reaches at least 5 and the counter values are at least 100. At the time it became true, the hysteresis value would be subtracted from the threshold (setting the threshold to 4). With the threshold now at 4, the condition would stay true until the ratio of the counters became less than 4.

If the statement becomes false, the threshold is reset to its original value. You use the hysteresis value to prevent the rule from vacillating between the true and false states if the ratio between the counter values is near the threshold. If the hysteresis value is greater than the threshold value, the hysteresis value will be set to 0.

In [Table 102](#) is an example of evaluating the CLEAR-Flow ratio expression above multiple times. Notice that the rule is not triggered at the first evaluation because both counters have not yet reached the min-value of 100. The rule first triggers at evaluation 3, when ratio of the two counters exceeds 5. After the rule is triggered, it remains triggered until the ratio value is less than 4 (the original threshold minus the hysteresis), at evaluation 5. At evaluation 7, the rule is again triggered when the ratio reaches 5. The rule will remain triggered until the ratio drops below 4.

Table 102: Ratio Expression Evaluation Example

Evaluation	counter1 value	counter2 value	ratio	Rule triggered?
1	427	70	6	No
2	941	235	4	No
3	2475	412	6	Yes
4	2308	570	4	Yes
5	2313	771	3	No
6	3597	899	4	No
7	5340	1065	5	Yes

See [“Ratio Expression Example” on page 928](#) for a full example of an ACL and a CLEAR-Flow rule using a ratio expression.

Delta-Ratio Expression

A CLEAR-Flow delta-ratio expression is a combination of the delta and ratio expressions. The CLEAR-Flow agent computes the difference from one sample to the next for each of the two counters. The ratio of the differences is then compared to the threshold value. The following is the syntax for a CLEAR-Flow delta-ratio expression (note the similarity to the delta expression):

```
delta-ratio <counterNameA> <counterNameB> REL_OPER <countThreshold> ;
min-value <min-value> ;
hysteresis <hysteresis> ;
```

The value of `<countThreshold>` and `<hysteresis>` can be specified as floating point numbers, and the `delta-ratio` is computed as a floating point number. The `delta-ratio` statement specifies how to compare the ratio of the counter differences with its threshold. The difference of the sample values of `<counterNameA>` is divided by the difference of the sample values of `<counterNameB>`, to compute the ratio that is compared with the `<countThreshold>`. The `REL_OPER` is selected from the relational operators for greater than, greater than or equal to, less than, or less than or equal to (`>`, `>=`, `<`, `<=`).

The `min-value` statement is optional, and sets a minimum value for the counters. If either counter is less than the minimum value, the expression evaluates to false. If not specified, the minimum value is 1.

The `hysteresis <hysteresis>` statement is optional, and sets a hysteresis value for the threshold. After the `ratio` statement is true, the value of the threshold is adjusted so that a change smaller than the hysteresis value will not cause the statement to become false. For statements using the `REL_OPER >` or `>=`, the hysteresis value is subtracted from the threshold; for `<` or `<=`, the hysteresis value is added to the threshold.

For example, the following delta-ratio expression:

```
delta-ratio counter1 counter2 >= 5 ;
min-value 100 ;
hysteresis 1 ;
```

will only be true after the ratio of the deltas of the counters reached at least 5. At the time it became true, the hysteresis value would be subtracted from the threshold (setting the threshold to 4). With the threshold now at 4, the condition would stay true until the ratio of the deltas of the counters became less than 4.

If the statement becomes false, the threshold is reset to its original value. You would use the hysteresis value to prevent the rule from vacillating between the true and false states if the ratio of the deltas of the counters is near the threshold. If the hysteresis value is greater than the threshold value, the hysteresis value will be set to 0.

In [Table 103](#) is an example of evaluating the CLEAR-Flow delta-ratio expression above multiple times. Notice that the rule is not triggered at the second evaluation because both counters have not yet reached the min-value of 100. The rule first triggers at evaluation 4, when ratio of the two counters exceeds 5. After the rule is triggered, it remains triggered until the ratio value is less than 4 (the original threshold minus the hysteresis), at evaluation 6. At evaluation 8, the rule is again triggered when the ratio reaches 5. The rule will remain triggered until the ratio drops below 4.

Table 103: Delta-Ratio Expression Evaluation Example

Evaluation	counter1 value	counter1 delta	counter2 value	counter2 delta	Ratio	Rule triggered?
1	110	N/A	20	N/A	N/A	No
2	537	427	90	70	6	No
3	1478	941	325	235	4	No
4	3953	2475	737	412	6	Yes
5	6261	2308	1307	570	4	Yes
6	8574	2313	2078	771	3	No
7	12171	3597	2977	899	4	No
8	17511	5340	4042	1065	5	Yes

See [“Delta-Ratio Expression Example” on page 929](#) for a full example of an ACL and a CLEAR-Flow rule using a delta-ratio expression.

Rule-True-Count Expression

A CLEAR-Flow rule-true-count expression compares how many times a CLEAR-Flow rule is true with a threshold value. One use is to combine multiple rules together into a complex rule. The following is the syntax for a CLEAR-Flow rule-true-count expression:

```
rule-true-count <ruleName> REL_OPER <countThreshold> ;
```

The `rule-true-count` statement specifies how to compare how many times a CLEAR-Flow rule is true with the expression threshold. The `<ruleName>` is the name of the CLEAR-Flow rule to monitor and the `<countThreshold>` is the value compared with the number of times the rule is true. The `REL_OPER` is selected from the relational operators for greater than, greater than or equal to, less than, or less than or equal to (`>`, `>=`, `<`, `<=`).

For example, the following delta-ratio expression:

```
rule-true-count cflow_count_rule_example >= 5 ;
```

will only be true after the CLEAR-Flow rule *cflow_count_rule_example* has been true at least five times. If the rule *cflow_count_rule_example* becomes true and remains true, and the period for *cflow_count_rule_example* is the default five seconds, the rule would have to be true for at least 20 seconds before the rule-true-count expression will become true. If the period of the rule *cflow_count_rule_example* is 10 seconds, it will need to be true for at least 40 seconds before the rule-true-count expression becomes true.

CLEAR-Flow Rule Actions

CLEAR-Flow rules specify an action to take when the rule is triggered and can optionally specify an action to take when the expression is false. Because more than one action can be taken in a single rule, the collection of actions is referred to as an action list.

The actions that can be taken are:

- [Permit/Deny](#)
- [QoS Profile](#)
- [Mirror](#)
- [SNMP Trap](#)
- [Syslog](#)
- [CLI](#)

Additionally, the SNMP trap, syslog, and CLI rule actions can use keyword substitution to make the rule actions more flexible. The keyword substitutions are described at the end of the rule action descriptions. See [“Keyword Substitution” on page 924](#) for more information.

The following sections describe the different rule actions.

Permit/Deny

This action modifies an existing ACL rule to permit or block traffic that matches that rule.

To change an ACL to permit, use the following syntax:

```
permit <ACLRuleName>
```

To change an ACL to deny, use the following syntax:

```
deny <ACLRuleName>
```

QoS Profile

This action modifies an existing ACL rule to set the QoS profile for traffic that matches that rule.

To change the ACL to forward to QoS profile <QPx>, use the following syntax:

```
qosprofile <ACLRuleName> <QPx>
```

For example:

```
qosprofile acl_rule_1 QP3
```

Mirror

This action modifies an existing ACL rule to mirror traffic that matches that rule, or to stop mirroring that traffic. The mirroring port must be enabled when mirroring on an ACL rule is turned on. This could be configured earlier, or use the CLI action to execute CLI commands to configure mirroring at the same time.

To change the ACL to mirror traffic, use the following syntax:

```
mirror [add|delete] <ACLRuleName>
```

For example (enabling mirroring from within CLEAR-Flow rule):

```
cli "enable mirroring to port 7:4 tagged"
mirror add acl_rule_1
```

SNMP Trap

This action sends an SNMP trap message to the trap server, with a configurable ID and message string, when the rule is triggered.

The message is sent periodically with interval `<period>` seconds. If `<period>` is 0, or if this optional parameter is not present, the message is sent only once when the rule is triggered. The interval must be a multiple of the rule sampling/evaluation interval, or the value will be rounded down to a multiple of the rule sampling/evaluation interval.

To send an SNMP trap, use the following syntax:

```
snmptrap <id> <message> <period>
```

Syslog

This action sends log messages to the ExtremeXOS EMS sever. The possible values for message level are: DEBU, INFO, NOTI, WARN, ERRO, and CRIT.

The message is sent periodically with interval `<period>` seconds. If `<period>` is 0, or if this optional parameter is not present, the message is sent only once when the rule is triggered. The interval must be a multiple of the rule sampling/evaluation interval, or the value will be rounded down to a multiple of the rule sampling/evaluation interval.

The messages are logged on both management modules (MSMs/MMs), so if the backup log is sent to the primary MSM/MM, then the primary MSM/MM will have duplicate log messages.

To send a log message, use the following syntax:

```
syslog <message> <level> <period>
```

CLI

This action executes a CLI command. There is no authentication or checking the validity of each command. If a command fails, the CLI will log a message in the EMS log.

To execute a CLI command, use the following syntax:

```
cli <cliCommand>
```

where `<cliCommand>` is a quoted string.

Keyword Substitution

To make the SNMP trap, syslog, and CLI actions more flexible, keyword substitutions are supported in the syslog and SNMP trap message strings, as well as in the CLI command strings. [Table 104](#) lists the keywords and their substitutions.

If a keyword is not supported, or a counter name is not found, a string of “unknownKeyword[\$keyword]” will be substituted.

For the \$vlanName and \$port keyword, the keyword `all` will be substituted for those rules in the wildcard ACL. Some CLI commands do not support the `all` keyword, so caution must be used with CLI commands that use this feature.

A maximum of 10 different counter substitutions can be used per rule, including counters used in expressions. For example, if a rule uses four counters in its expressions, then we can use six more different counters in keyword substitutions, for a total of 10.

Table 104: Keyword Substitutions

Keyword	Substitution
\$policyName	Replace with the policy name.
\$ruleName	Replace with the CLEAR-Flow rule name.
\$<counterName>	Replace with counter value for the indicated counter name.
\$ruleValue	Replace with the current expression value.
\$ruleThreshold	Replace with the expression threshold value.
\$ruleInterval	Replace with the rule sampling/evaluation interval.
\$vlanName	Replace with the interface VLAN name.
\$port	Replace with the interface port number.

Predefined CLEAR-Flow Counters

A number of packet statistics are gathered by the XOS kernel. To allow you to use these statistics in CLEAR-Flow expressions, these kernel counters are now available for use with CLEAR-Flow. Most of the counter names are based directly on well known names from common kernel structures and MIBs. The names are modified from their familiar form by prepending the characters `sys_` to the counter names.

Table 105: Predefined CLEAR-Flow Counters

Counter Name	Description ^a
sys_ipInReceives	The total number of input IP packets received from interfaces, including those received in error.
sys_ipInHdrErrors	The number of input IP packets discarded due to errors in their IP headers, including bad checksums, version number mismatch, other format errors, time-to-live exceeded, errors discovered in processing their IP options, etc.
sys_ipInAddrErrors	The number of input IP packets discarded because the IP address in their IP header's destination field was not a valid address to be received at this entity. This count includes invalid addresses (for example, 0.0.0.0) and addresses of unsupported Classes (for example, Class E).

Table 105: Predefined CLEAR-Flow Counters (Continued)

Counter Name	Description ^a
sys_ipFwdDatagrams	The number of input IP packets for which this entity was not their final IP destination, as a result of which an attempt was made to find a route to forward them to that final destination.
sys_ipInUnknownProtos	The number of locally-addressed IP packets received successfully but discarded because of an unknown or unsupported protocol.
sys_ipInDiscards	The number of input IP packets for which no problems were encountered to prevent their continued processing, but which were discarded (for example, for lack of buffer space). Note that this counter does not include any IP packets discarded while awaiting re-assembly.
sys_ipInDelivers	The total number of input IP packets successfully delivered to IP user-protocols (including ICMP).
sys_ipOutRequests	The total number of IP packets which local IP user-protocols (including ICMP) supplied to IP in requests for transmission. Note that this counter does not include any IP packets counted in ipFwdDatagrams.
sys_ipOutDiscards	The number of output IP packets for which no problem was encountered to prevent their transmission to their destination, but which were discarded (for example, for lack of buffer space). Note that this counter would include IP packets counted in ipFwdDatagrams if any such packets met this (discretionary) discard criterion.
sys_ipOutNoRoutes	The number of IP packets discarded because no route could be found to transmit them to their destination. Note that this counter includes any packets counted in ipFwdDatagrams which meet this 'no-route' criterion.
sys_ipReasmTimeout	The maximum number of seconds which received fragments are held while they are awaiting reassembly at this entity.
sys_ipReasmReqds	The number of IP fragments received which needed to be reassembled at this entity.
sys_ipReasmOKs	The number of IP packets successfully re-assembled.
sys_ipReasmFails	The number of failures detected by the IP re-assembly algorithm (for whatever reason: timed out, errors, etc.). Note that this is not necessarily a count of discarded IP fragments since some algorithms (notably the algorithm in RFC 815) can lose track of the number of fragments by combining them as they are received.
sys_ipFragOKs	The number of IP packets that have been successfully fragmented at this entity.
sys_ipFragFails	The number of IP packets that have been discarded because they needed to be fragmented at this entity but could not be, for example, because their Don't Fragment flag was set.
sys_ipFragCreates	The number of IP packet fragments that have been generated as a result of fragmentation at this entity.
sys_icmplnMsgs	The total number of ICMP messages which the entity received. Note that this counter includes all those counted by icmplnErrors.
sys_icmplnErrors	The number of ICMP messages which the entity received but determined as having ICMP-specific errors (bad ICMP checksums, bad length, etc.).
sys_icmplnDestUnreachs	The number of ICMP Destination Unreachable messages received.
sys_icmplnTimeExcds	The number of ICMP Time Exceeded messages received.
sys_icmplnParmProbs	The number of ICMP Parameter Problem messages received.
sys_icmplnSrcQuenchs	The number of ICMP Source Quench messages received.
sys_icmplnRedirects	The number of ICMP Redirect messages received.
sys_icmplnEchoss	The number of ICMP Echo (request) messages received.
sys_icmplnEchoReps	The number of ICMP Echo Reply messages received.

Table 105: Predefined CLEAR-Flow Counters (Continued)

Counter Name	Description ^a
sys_IcmpInTimestamps	The number of ICMP Timestamp (request) messages received.
sys_IcmpInTimestampReps	The number of ICMP Timestamp Reply messages received.
sys_IcmpInAddrMasks	The number of ICMP Address Mask Request messages received.
sys_IcmpInAddrMaskReps	The number of ICMP Address Mask Reply messages received.
sys_IcmpOutMsgs	The total number of ICMP messages which this entity attempted to send. Note that this counter includes all those counted by icmpOutErrors.
sys_IcmpOutErrors	The number of ICMP messages which this entity did not send due to problems discovered within ICMP such as a lack of buffers. This value should not include errors discovered outside the ICMP layer such as the inability of IP to route the resultant datagram. In some implementations there may be no types of error which contribute to this counter's value.
sys_IcmpOutDestUnreachs	The number of ICMP Destination Unreachable messages sent.
sys_IcmpOutTimeExcds	The number of ICMP Time Exceeded messages sent.
sys_IcmpOutParmProbs	The number of ICMP Parameter Problem messages sent.
sys_IcmpOutSrcQuenchs	The number of ICMP Source Quench messages sent.
sys_IcmpOutRedirects	The number of ICMP Redirect messages sent.
sys_IcmpOutEchos	The number of ICMP Echo (request) messages sent.
sys_IcmpOutEchoReps	The number of ICMP Echo Reply messages sent.
sys_IcmpOutTimestamps	The number of ICMP Timestamp (request) messages sent.
sys_IcmpOutTimestampReps	The number of ICMP Timestamp Reply messages sent.
sys_IcmpOutAddrMasks	The number of ICMP Address Mask Request messages sent.
sys_IcmpOutAddrMaskReps	The number of ICMP Address Mask Reply messages sent.
sys_IcmpInProtoUnreachs	The number of incoming ICMP packets addressed to a not-in-use/unreachable/invalid protocol. This message is in the general category of ICMP destination unreachable error messages.
sys_IcmpInBadLen	The number of incoming bad ICMP length packets. ^b
sys_IcmpInBadCode	The number of incoming ICMP packets with a bad code field value.
sys_IcmpInTooShort	The number of incoming short ICMP packets.
sys_IcmpInBadChksum	The number of incoming ICMP packets with bad checksums.
sys_IcmpInRouterAdv	The number of incoming ICMP router advertisements. Router advertisements are used by IP hosts to discover addresses of neighboring routers.
sys_IcmpOutProtoUnreachs	The number of outgoing ICMP packets addressed to a not-in-use/unreachable/invalid protocol. This message is in the general category of ICMP destination unreachable error messages.
sys_IcmpOutRouterAdv	The number of outgoing ICMP router advertisements. Router advertisements are used by IP hosts to discover addresses of neighboring routers.
sys_IgmpInQueries	The number of Host Membership Query messages that have been received on this interface.
sys_IgmpInReports	The number of Host Membership Report messages that have been received on this interface for this group address.
sys_IgmpInLeaves	The number of incoming IGMP leave requests.
sys_IgmpInErrors	The number of incoming IGMP errors.
sys_IgmpOutQueries	The number of Host Membership Query messages that have been sent on this interface

Table 105: Predefined CLEAR-Flow Counters (Continued)

Counter Name	Description ^a
sys_igmpOutReports	The number of Host Membership Report messages that have been sent on this interface for this group address.
sys_igmpOutLeaves	The number of outgoing IGMP leave requests.

- a. Most of these descriptions can be found in RFC 2011, *SNMPv2 Management Information Base for the Internet Protocol using SMIPv2*.
- b. The length of an ICMP packet depends on the type and code field.

CLEAR-Flow Rule Examples

In the examples that follow, one to two ACL rule entries are followed by a CLEAR-Flow rule entry. The examples illustrate the four CLEAR-Flow rule expressions: count, delta, ratio, and delta-ratio.

Count Expression Example

In the following example, every 10 seconds the CLEAR-Flow agent will request the *counter1* statistics from the hardware. After it receives the counter value, it will evaluate the CLEAR-Flow rule. If the value of *counter1* is greater than 1000000 packets, the CLEAR-Flow agent will send a trap message to the SNMP master, and change the ACL *acl_rule1* to block traffic (*acl_rule1* is modified to a deny rule).

Since there is no period configured for the `snmptrap` statement, the message is sent only once.

```
entry acl_rule1 {
    if {
        destination-address 192.168.16.0/24;
        destination-port 2049;
        protocol tcp;
    } then {
        count counter1;
    }
}

entry cflow_count_rule_example {
    if { count counter1 > 1000000 ;
        period 10 ;
    }
    then {
        snmptrap 123 "Traffic on acl_rule1 exceeds threshold";
        deny acl_rule1;
    }
}
```

Delta Expression Example

In this example, every 10 seconds the CLEAR-Flow agent will request the *counter1* statistics from the hardware. After it receives the counter value, it will then evaluate the rule. If the delta (change) of the *counter1* value from the last sampled value 10 seconds ago is greater than or equal to 1000 packets, the CLEAR-Flow agent will send a trap message to the SNMP master, and change the ACL *acl_rule1* to move the traffic to QP3. In addition, reduce the peak rate to 5 Kbps on QP3. As long as the delta

continues to be greater than or equal to 1000 packets, the CLEAR-Flow agent will repeatedly send a trap message every 120 seconds. When the delta falls below the threshold, the agent will execute the two actions in the `else` portion; it will send a single SNMP trap message, return the traffic to QP1, and reset QP3 to its original bandwidth.

```
entry acl_rule1 {
    if {
        destination-address 192.168.16.0/24;
        destination-port 2049;
        protocol tcp;
    } then {
        count counter1;
    }
}

entry cflow_delta_rule_example {
    if { delta counter1 >= 100000 ;
        period 10 ;
    } then {
        snmptrap 123 "Traffic to 192.168.16.0/24 exceed rate limit" 120;
        qosprofile acl_rule1 QP3;
        cli "configure qosprofile qp3 peak_rate 5 K ports all" ;
    } else {
        snmptrap 123 "Traffic to 192.168.16.0/24 falls below rate limit";
        qosprofile acl_rule1 QP1;
        cli "configure qosprofile qp3 maxbw 100 ports all" ;
    }
}
```

Ratio Expression Example

In this example, every 2 seconds the CLEAR-Flow agent will request the *counter1* and *counter2* statistics from the hardware. After it receives the two counter values, it will then check each counter value against its minimum valid threshold, which is 1000. If both of the counter values is greater than 1000, it then calculates the ratio of *counter1* and *counter2*. If the ratio is greater than 5, then the agent will execute the actions in the `then` clause, which consists of logging a message to the syslog server. Before logging the syslog string, the agent will replace the `$ruleName` keyword with the string *cflow_ratio_rule_example*, the `$ruleValue` keyword with the calculated ratio value, and the `$ruleThreshold` keyword with a value of 5. If either of the counter values is below the minimum value of 1000, or the ratio is below the threshold of 5, the expression is false and no action is taken.

```
entry acl_rule1 {
    if {
        protocol udp;
    } then {
        count counter1;
    }
}

entry acl_rule2 {
    if {
        protocol tcp;
```

```

    } then {
        count counter2;
    }
}

entry cflow_ratio_rule_example {
    if { ratio counter1 counter2 > 5 ;
        period 2;
        min-value 1000;
    }
    then {
        syslog "Rule $ruleName threshold ratio $ruleValue exceeds limit
$ruleThreshold";
    }
}

```

Delta-Ratio Expression Example

In this example, every 2 seconds, the CLEAR-Flow agent will request the *tcpSynCounter* and *tcpCounter* values from the hardware. After it receives the two counter values, it will first calculate the delta for each of the counters and then check each counter's delta value for its minimum value, which is 100. If both of the counters' delta values are greater than 100, it then calculates the ratio of the delta of two counters. If the ratio is greater than 10, then the agent will log a warning message and deny all SYN traffic on the interface. No period value for the syslog message is given, so the message will be logged once when the expression first becomes true. When the expression transitions from true to false, a different message will be logged and the SYN traffic on the interface will be permitted again. The delta-ratio value has to fall below a threshold of 8 for the expression to be evaluated to be false.

```

entry acl_syn {
    if {
        protocol tcp_flags SYN;
    } then {
        count tcpSynCounter;
    }
}

entry acl_tcp {
    if {
        protocol tcp;
    } then {
        count tcpCounter;
    }
}

entry cflow_delta_ratio_rule_example {
    if { delta-ratio tcpSynCounter tcpCounter > 10 ;
        period 2;
        min-value 100;
        threshold 8;
    } then {
        syslog "Syn attack on port $port is detected" WARN;
        deny acl_syn;
    }
}

```

```
    } else {  
        syslog "Syn attack on port $port is no longer detected" WARN;  
        permit acl_syn;  
    }  
}
```

2

PART

Using Switching and Routing Protocols

25

CHAPTER

EAPS

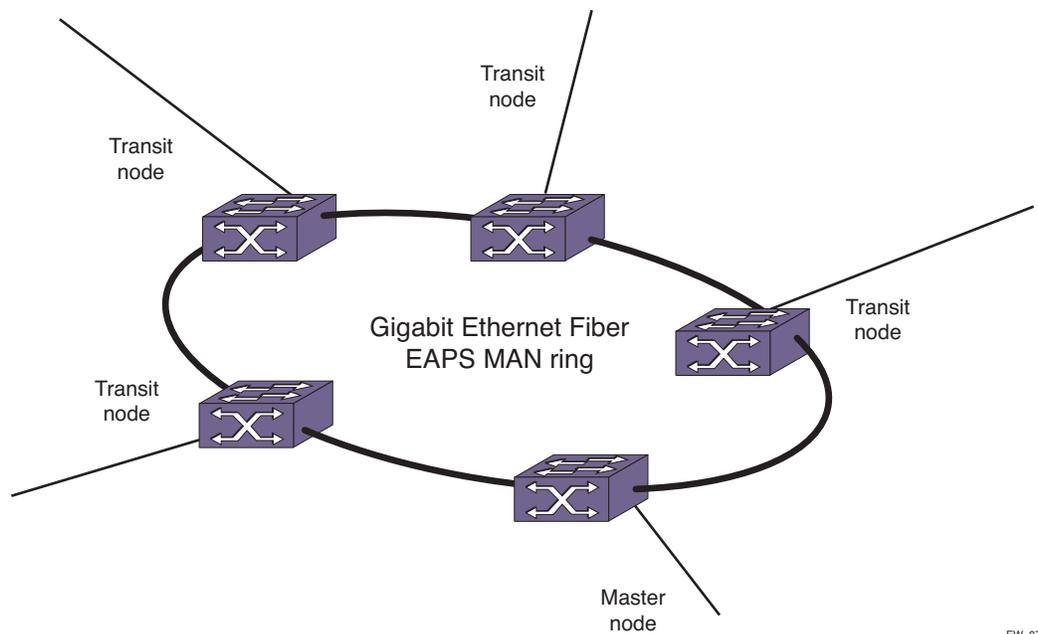
This chapter includes the following sections:

- [Overview on page 933](#)
- [Configuring EAPS on page 950](#)
- [Displaying EAPS Information on page 960](#)
- [Configuration Examples on page 961](#)
- [CFM Support in EAPS on page 994](#)

Overview

The EAPS protocol provides fast protection switching to Layer 2 switches interconnected in an Ethernet ring topology, such as a Metropolitan Area Network (MAN) or large campus (see [Figure 107](#)).

Figure 107: Gigabit Ethernet Fiber EAPS MAN Ring



The following sections provide additional overview information on EAPS:

- [EAPS Benefits on page 934](#)
- [EAPS Single Ring Topology on page 934](#)
- [EAPS Multiple Ring Topology on page 939](#)
- [Fast Convergence on page 949](#)
- [EAPS and Hitless Failover—Modular Switches and SummitStack Only on page 949](#)
- [EAPS Licensing on page 950](#)

EAPS Benefits

EAPS offers the following benefits:

- **50ms recovery time for link or node failures:** When a link failure or switch failure occurs, EAPS recovers within 50 milliseconds, comparable to SONET. EAPS provides resiliency for voice, video, and data services.
- **Scalable network segmentation and fault isolation:** EAPS domains can protect groups of multiple VLANs allowing scalable growth and broadcast loop protection. EAPS domains provide logical and physical segmentation, which means failures in one EAPS ring do not impact network service for other rings and VLANs.
- **Resilient foundation for non-stop IP routing services:** EAPS provides a resilient foundation for upper level routing protocols such as Open Shortest Path First (OSPF) and Border Gateway Protocol (BGP), minimizing route-flapping and dropped neighbors within the routed IP network.
- **Predictable convergence regardless of failure location:** EAPS provides consistent and predictable recovery behavior regardless of where link failures occur. The simple blocking architecture and predictable performance of EAPS allows for enforceable Service Level Agreements (SLAs). This allows easier network troubleshooting and failure scenario analysis without lengthy testing or debugging on live production networks.

EAPS protection switching is similar to what can be achieved with the Spanning Tree Protocol (STP), but EAPS offers the advantage of converging in less than 1 second when a link in the ring breaks.

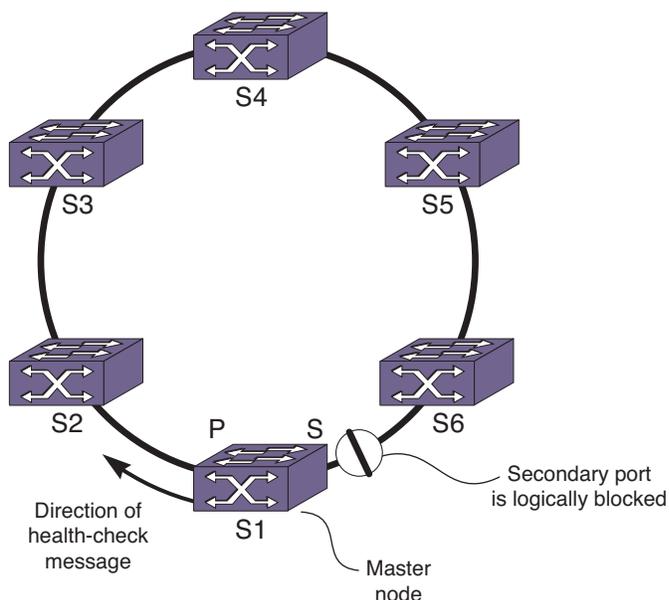
An Ethernet ring built using EAPS can have resilience comparable to that provided by SONET rings, at a lower cost and with fewer restraints (such as ring size). The EAPS technology developed by Extreme Networks to increase the availability and robustness of Ethernet rings is described in *RFC 3619: Extreme Networks' Ethernet Automatic Protection Switching (EAPS) Version 1*.

EAPS Single Ring Topology

The simplest EAPS configuration operates on a single ring. This section describes how this type of EAPS configuration operates. Later sections describe more complex configurations.

An EAPS domain consists of one *master node* and one or more *transit nodes* (see [Figure 108](#)), and includes one *control VLAN* and one or more *protected VLANs*. A domain is a single instance of the EAPS protocol that defines the scope of protocol operation. A single logical EAPS domain typically exists on a given physical ring topology (fiber or copper).

Figure 108: EAPS Operation



EW_071

A *protected VLAN* is a user data VLAN that uses the ring for a protected connection between all edge ports. The protected VLAN uses 802.1q trunking on the ring ports and supports tagged and untagged edge ports.

One ring port of the master node is designated the master node's *primary* port (P), and another port is designated as the master node's *secondary* port (S) to the ring. In normal operation, the master node blocks the secondary port for all protected VLAN traffic, thereby preventing a loop in the ring. (The spanning tree protocol, STP, provides the same type of protection). Traditional Ethernet bridge learning and forwarding database mechanisms direct user data around the ring within the protected VLANs.

**NOTE**

Although primary and secondary ports are configured on transit nodes, both port types operate identically as long as the transit node remains a transit node. If the transit node is reconfigured as a master node, the configured states of the primary and secondary ports apply.

The *control VLAN* is a dedicated 802.1q tagged VLAN that is used to transmit and receive EAPS control frames on the ring. The control VLAN can contain only two EAPS ring ports on each node. Each EAPS domain has a unique control VLAN, and control traffic is not blocked by the master node at any time. The control VLAN carries the following EAPS control messages around the ring:

- *Health-check messages*, which are sent from the master node primary port. Transit nodes forward health-check messages toward the master node secondary port on the control VLAN. When the master node receives a health check message on the secondary port, the EAPS ring is considered intact.
- *Link-down alert messages*, which are sent from a transit node to the master node when the transit node detects a local link failure.
- *Flush-FDB messages*, which are sent by the master node to all transit nodes when ring topology changes occur. Upon receiving this control frame, the transit node clears its MAC address forwarding table (FDB) and relearns the ring topology.

When the master node detects a failure, due to an absence of health-check messages or a received link-down alert, it transitions the EAPS domain to the *Failed* state and unblocks its secondary port to allow data connectivity in the protected VLANs.

The following sections describe additional EAPS features that apply to a single ring:

- [Master Node States on page 936](#)
- [Transit Node States on page 936](#)
- [Single Ring Fault Detection and Recovery on page 936](#)
- [Multiple EAPS Domains per Ring—Spatial Reuse on page 938](#)

Master Node States

The master node can be in either of the following states:

- **Complete:** This is the master node status during normal operation when no link failure exists on the ring. Complete status indicates the master node successfully transmitted health-check status frames around the network. In this state, the secondary port of the master node is logically blocking traffic on protected VLANs.
- **Failed:** This is the master node status when a link failure exists on the ring. Failed status indicates that the master node has received a *link-down alert* or the fail-timer expired without receiving a health-check frame.

Transit Node States

A transit node can be in any of the following states:

- **Links-Up:** This is the transit node state during normal operation when both of its directly attached ring ports are active.
- **Links-Down:** This state indicates the node has one or two ring ports in failed state.
- **Pre-Forwarding:** This transit node port state occurs when one of the node ring ports is restored (after a prior link failure). During this state, the port temporarily blocks protected VLAN traffic and prevents broadcast loops during state transitions.

Single Ring Fault Detection and Recovery



NOTE

To avoid loops in the network, the control VLAN must NOT be configured with an IP address, and ONLY ring ports may be added to this VLAN.

A master node identifies a ring fault when it detects one of the following events:

- A link down message sent by a transit node
- A local ring port down event sent by the hardware
- No response to a health-check polling message

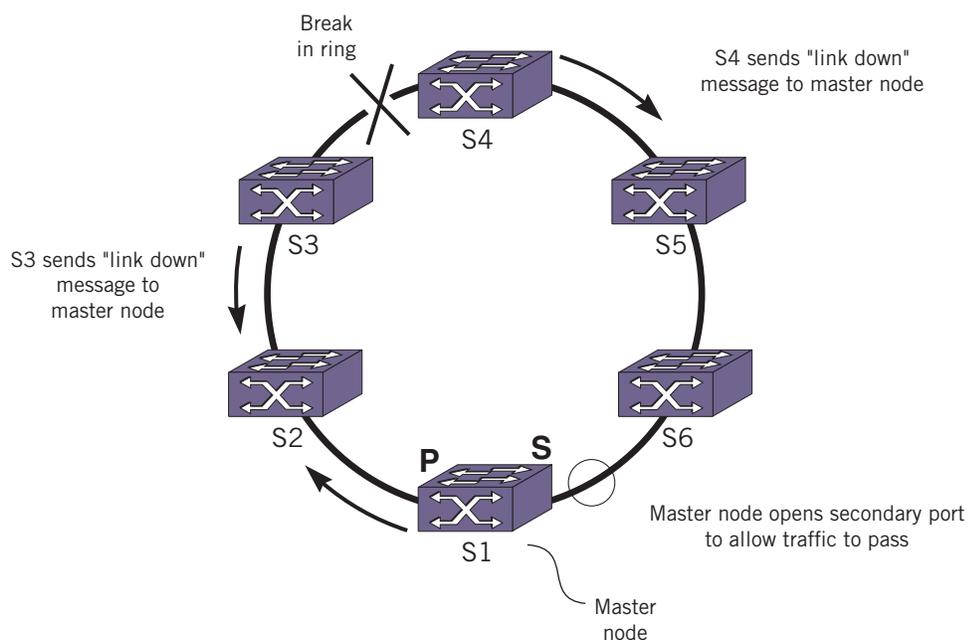
The following sections provide more information on these events and on fault recovery:

- [Link Down Events on page 937](#)
- [Ring Port Down Events on page 937](#)
- [Health Check Polling on page 937](#)
- [Ring Fault Recovery on page 938](#)

Link Down Events. When any transit node detects a loss of link connectivity on any of its ring ports, it immediately sends a *link down* message on the control VLAN using its good link to the master node.

When the master node receives the link down message (see [Figure 109](#)), it immediately declares a *failed* state and opens its logically blocked secondary port for all the protected VLANs. Now, traffic can flow through the master node secondary port. The master node also flushes its FDB and sends a message on the control VLAN to all of its associated transit nodes to flush their forwarding databases as well, so that all of the switches can learn the new paths to Layer 2 endstations on the reconfigured ring topology.

Figure 109: EAPS Fault Detection and Protection Switching



EW_072

Ring Port Down Events. When a ring port goes down on a master node, the hardware layer notifies the software layer, and the ring port immediately goes into a *failed* state.

If the failed ring port is the primary port, the master node removes the block on the secondary port. The master node also flushes the FDB and sends a *flush FDB* message to all transit nodes.

Health Check Polling. The master node transmits a health check packet on the control VLAN at a user-configurable interval (see [Figure 108](#)). If the ring is complete, the master node receives the health-check packet on its secondary port (the control VLAN is not blocked on the secondary port). When the master node receives the health-check packet, it resets its failtimer and continues normal operation.

If the master node does not receive the health check packet before the failtimer interval expires and the failtime expiry action is set to `open-secondary-port`, it declares a *failed* state and does the following:

- Unblocks its secondary port for use by the protected VLANs.
- Flushes its forwarding database (FDB).
- Sends a *flush FDB* message to its associated transit nodes.

Ring Fault Recovery. When the master node is operating in the failed state, it continues to send health check packets out the primary port. As long as there is a break in the ring, the fail period timer continues to expire, and the master node remains in the failed state.

When the broken link is restored, the master receives its health check packet on its secondary port and responds by doing the following:

- Declares the ring to be complete.
- Blocks the protected VLANs on its secondary port.
- Flushes its FDB.
- Sends a *flush FDB* message to its associated transit nodes.

During the time between when the transit node detects that the link is operable and when the master node detects that the ring is complete, the secondary port on the master node is still open and data could start traversing the transit node port that just came up.

To prevent the possibility of a such a temporary loop, a transit node that detects a failed link recovery does the following:

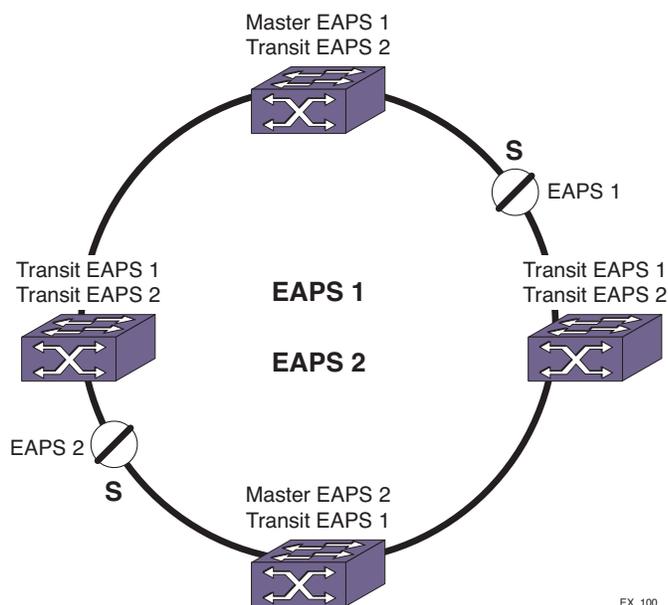
- 1 For the port that just came up, it places all the protected VLANs traversing that port into a temporary blocked state.
- 2 It remembers which port has been temporarily blocked.
- 3 It sets the port state to *Preforwarding*.

When the transit nodes receive the flush FDB message from the master node, they perform these steps:

- 1 Flush their forwarding databases for the protected VLANs.
- 2 If the port state is set to *Preforwarding*, remove the block for protected VLANs on the port.

Multiple EAPS Domains per Ring—Spatial Reuse

To take advantage of the spatial reuse technology and broaden the use of the ring's bandwidth, EAPS supports multiple EAPS domains running on the ring at the same time ([Figure 110](#)).

Figure 110: Multiple EAPS Domains Per Ring

A single ring might have two EAPS domains running on it. Each EAPS domain has a different EAPS master node. Each EAPS domain protects its own set of protected VLANs.

**NOTE**

In a spatial reuse configuration, do not add the same protected VLAN to both EAPS domains.

EAPS Multiple Ring Topology

EAPS works with multiple ring networks to support more complex topologies for interconnecting multiple EAPS domains. This allows larger EAPS end-to-end networks to be built from edge to core.

**NOTE**

Minimal EAPS support is provided at all license levels. EAPS multiple ring topologies and common link topologies are supported at higher license levels as described in [Appendix A, "Feature License Requirements."](#)

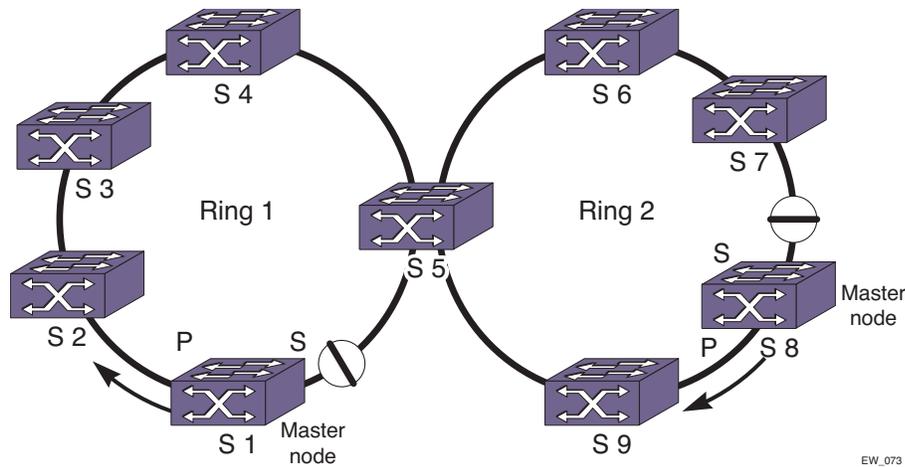
The simplest multiple ring topology uses a single switch to join two EAPS rings. The *common link* feature uses two switches, which share a common link, to provide redundancy and link multiple EAPS rings. The following sections describe some common EAPS multiple ring topologies:

- [Two Rings Connected by One Switch on page 940](#)
- [Multiple Rings Sharing an EAPS Common Link on page 940](#)
- [Spatial Reuse with an EAPS Common Link on page 946](#)

Two Rings Connected by One Switch

Figure 111 shows how a data VLAN can span two rings interconnected by a common switch—a *figure eight* topology.

Figure 111: Two Rings Interconnected by One Switch



A data VLAN that spans multiple physical rings or EAPS domains and is protected by EAPS is called an *overlapping VLAN*. An overlapping VLAN requires loop protection for each EAPS domain to which it belongs.

In Figure 111, there is an EAPS domain with its own control VLAN running on ring 1 and another EAPS domain with its own control VLAN running on ring 2. A data VLAN that spans both rings is added as a protected VLAN to both EAPS domains to create an overlapping VLAN. Switch S5 has two instances of EAPS domains running on it, one for each ring.

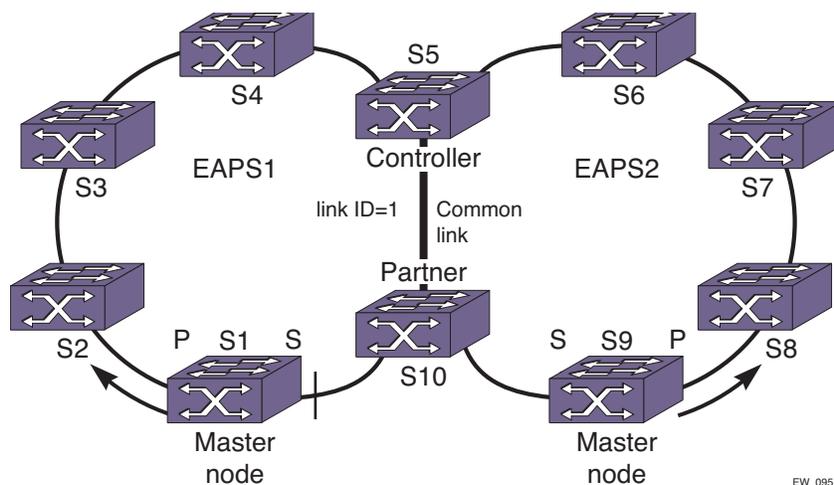
Multiple Rings Sharing an EAPS Common Link

The following sections describe the EAPS common link feature:

- [EAPS Common Link Operation on page 940](#)
- [Common Link Fault Detection and Response on page 943](#)
- [Common Link Recovery on page 945](#)
- [Controller and Partner Node States on page 946](#)

EAPS Common Link Operation. Figure 112 shows an example of a multiple ring topology that uses the EAPS common link feature to provide redundancy for the switches that connect the rings.

Figure 112: Multiple Rings Sharing a Common Link



An EAPS *common link* is a physical link that carries overlapping VLANs that are protected by more than one EAPS domain.

In the example shown earlier in [Figure 111](#), switch S5 could be a single point of failure. If switch S5 were to go down, users on Ring 1 would not be able to communicate with users on Ring 2. To make the network more resilient, you can add another switch. In [Figure 112](#), a second switch, S10, connects to both rings and to S5 through a common link, which is common to both rings.

The EAPS common link in [Figure 112](#) requires special configuration to prevent a loop that spans both rings. The software entity that requires configuration is the *eaps shared-port*, so the common link feature is sometimes called the *shared port* feature.



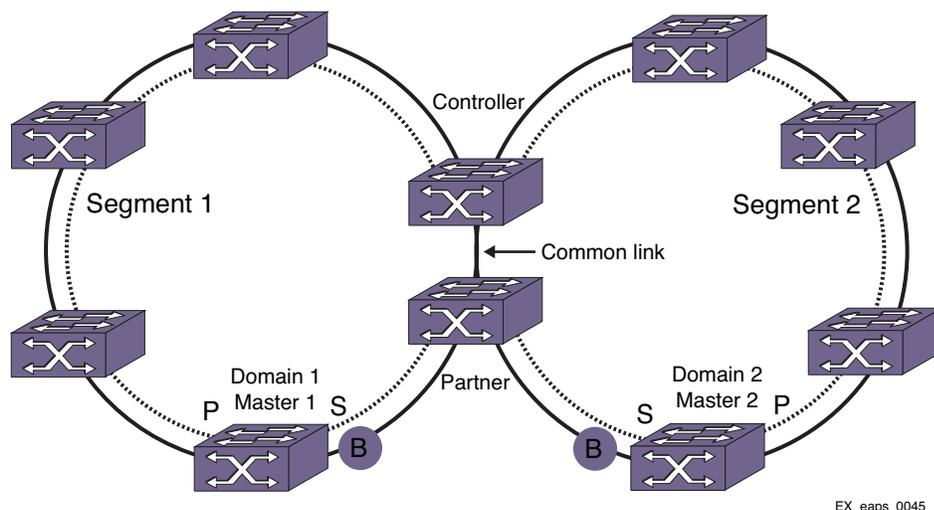
NOTE

If the shared port is not configured and the common link goes down, a superloop between the multiple EAPS domains occurs.

The correct EAPS common link configuration requires an EAPS shared port at each end of the common link. The role of the shared port (and switch) at each end of the common link must be configured as either *controller* or *partner*. Each common link requires one controller and one partner for each EAPS domain. Typically the controller and partner nodes are distribution or core switches. A controller or partner can also perform the role of master or transit node within its EAPS domain.

During normal operation, the master node on each ring protects the ring as described earlier in [“EAPS Single Ring Topology”](#) on page 934. The controller and partner nodes work together to protect the overlapping VLANs from problems caused by a common link failure or a failed controller (see [Figure 113](#)).

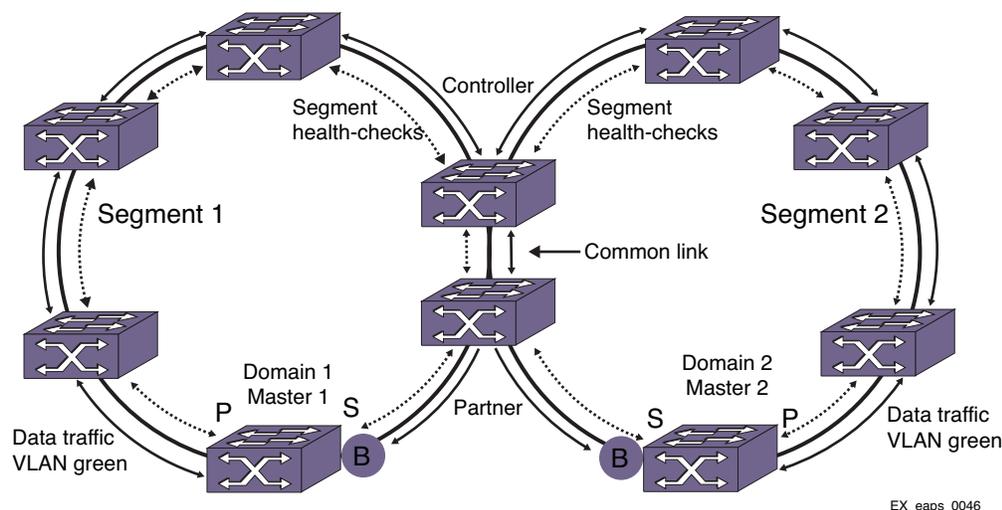
Figure 113: Master Node Operation in a Multiple Ring Topology



If a link failure occurs in one of the outer rings, only a single EAPS domain is affected. The EAPS master detects the failure in its domain, and converges around the failure. In this case, the controller does not take any blocking action, and EAPS domains on other rings are not affected. Likewise, when the link is restored, only the local EAPS domain is affected. The controller and any EAPS domains on other rings are not affected, and continue forwarding traffic normally.

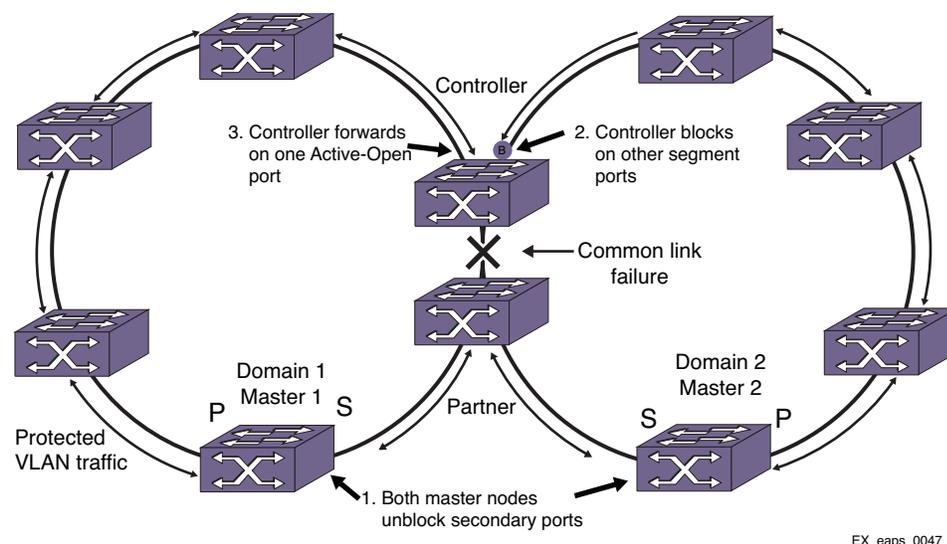
To detect common-link faults, the controller and partner nodes send *segment health check messages* at one-second intervals to each other through each segment. A *segment* is the ring communication path between the controller and partner. The common link completes the ring, but it is a separate entity from the segment. To discover segments and their up or down status, segment health-check messages are sent from controller to partner, and also from partner to controller (see Figure 114).

Figure 114: Segment Health-Check Messages



Common Link Fault Detection and Response. With one exception, when a common link fails, each master node detects the failure and unblocks its secondary port as shown in [Figure 115](#).

Figure 115: Common Link Failure



Because the secondary port of each master node is now unblocked, the new topology introduces a broadcast loop spanning the outer rings. The controller and partner nodes immediately detect the loop, and the controller does the following:

- Selects an active-open port for protected VLAN communications
- Blocks protected VLAN communications on all segment ports except the active-open port



NOTE

When a controller goes into or out of the blocking state, the controller sends a flush-fdb message to flush the FDB in each of the switches in its segments. In a network with multiple EAPS ports in the blocking state, the flush-fdb message gets propagated across the boundaries of the EAPS domains.

The exception mentioned above occurs when the partner node is also a master node, and the shared port that fails is configured as a primary port. In this situation, the master node waits for a link-down PDU from the controller node before opening the secondary port. This delay prevents a loop that might otherwise develop if the master/partner node detects the link failure before the controller node.



NOTE

If the common link and a ring link fail, and if the common link restores before the ring link, traffic down time can be as long as 3 seconds. This extended delay is required to prevent loops during the recovery of multiple failed links.

The master node selects the active-open port differently for the following EAPS configurations:

- Multiple ring topology without a PBBN
- Multiple ring topology with a PBBN

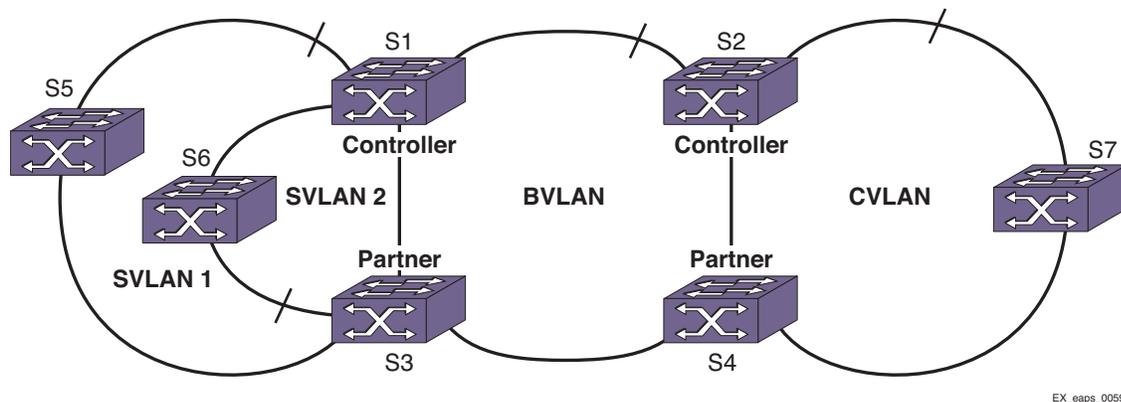
When no PBBN is present and the common link fails, the controller node selects the active-open port by choosing the lowest port number from the group of segment ports in the *Up* state. If the active-open port fails, the controller selects another active-open port using the same criteria. If the original active-open port recovers, the controller does not revert back to that port. When planning your configuration, you might want to plan your port configurations so that the desired active-open port (for example, a high bandwidth link) has a lower port number than other segment ports.

**NOTE**

The order that you add EAPS domains to EAPS shared ports is relevant if the EAPS domains have matching ring ports and participate in spatial reuse. In this case, the `show eaps shared-port {<port>} {detail}` command displays the newly added EAPS domain after all other existing EAPS domains with the same matching ring port.

When the topology supports both EAPS and a PBBN (as shown in [Figure 116](#)), the controller node automatically learns the relationship between the access VLANs (CVLANs or SVLANs) and the core VLAN (BVLAN). If the common link fails in this configuration, the master node selects the port leading to the BVLAN as the active-open port, providing priority support for protected VLANs on the core network. (For an example, see “[Example EAPS and PBB Configuration](#)” on page 989.)

Figure 116: Combined EAPS and PBBN Topology



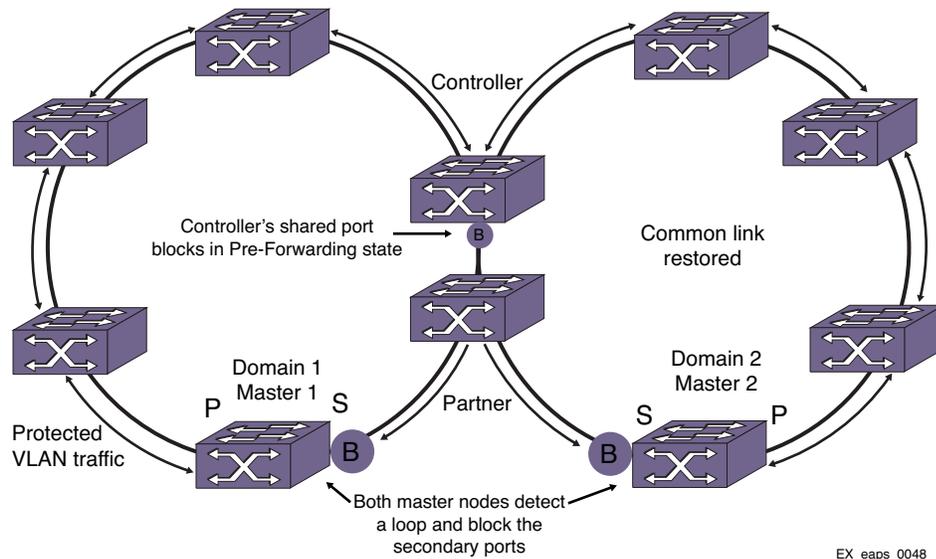
In [Figure 116](#) for example, the BVLAN EAPS ring protects the core network, which is made up of switches S1, S2, S3, and S4. Switch S2 is the master for this ring and blocks the secondary port to prevent a network loop. A common link between switches S1 and S3 supports the BVLAN, SVLAN1, and SVLAN2 EAPS rings.

If the common link between S1 and S3 fails, switches S2, S5, and S6 unblock their secondary EAPS ports to maintain connectivity to all devices on each ring. To prevent a super loop and give priority to the core network, the S1 controller declares the port leading to switch S2 as the active-open port and blocks protected VLAN communications on the segment ports leading to switches S5 and S6. If the active-open port fails, the controller selects another segment port as the active-open port. If the original active-open port recovers, the controller reverts back to the original active-open port.

If you have an EAPS configuration with multiple common links and a second common link fails, the controllers continue to take steps to prevent a superloop. In addition to having one controller with an active-open port, the controller with the smallest link ID becomes the *root blocker*. There can be only one root blocker in the network.

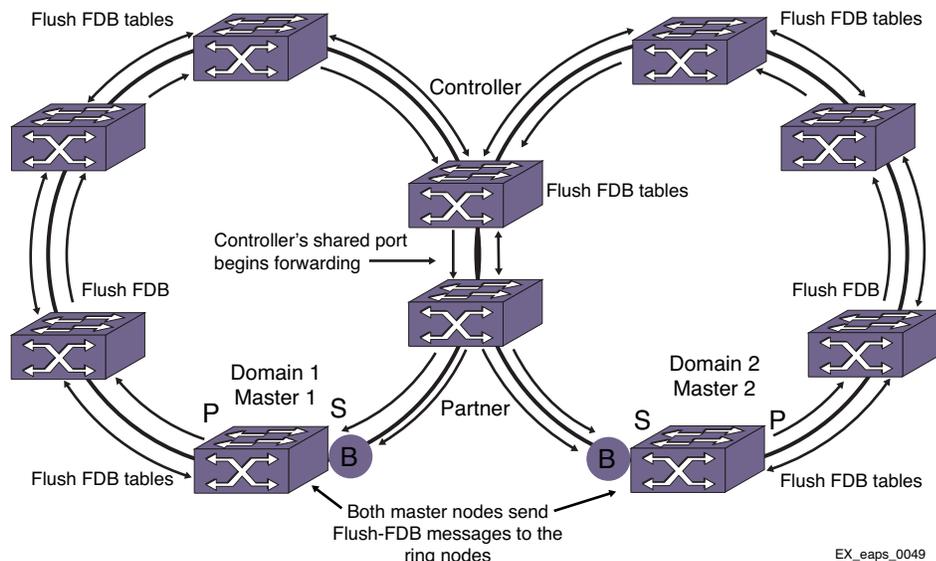
Common Link Recovery. When a common link recovers, each master node detects that the ring is complete and immediately blocks their secondary ports. The controller also detects the recovery and puts its shared port to the common link into a temporary blocking state called *pre-forwarding* as shown in Figure 117.

Figure 117: Common Link in Pre-Forwarding State



Because the topology has changed, the EAPS nodes must learn the new traffic paths. Each master node notifies all switches in their domain to clear their FDB tables, and traditional Ethernet bridge learning and forwarding mechanisms establish the new traffic paths. Once the controller receives flush-FDB messages for all of its connected EAPS domains, the controller shared-port state for the common link changes to *forwarding*, the controller state changes to *Ready*, and traffic flows normally as shown in Figure 118.

Figure 118: Common-Link Restored



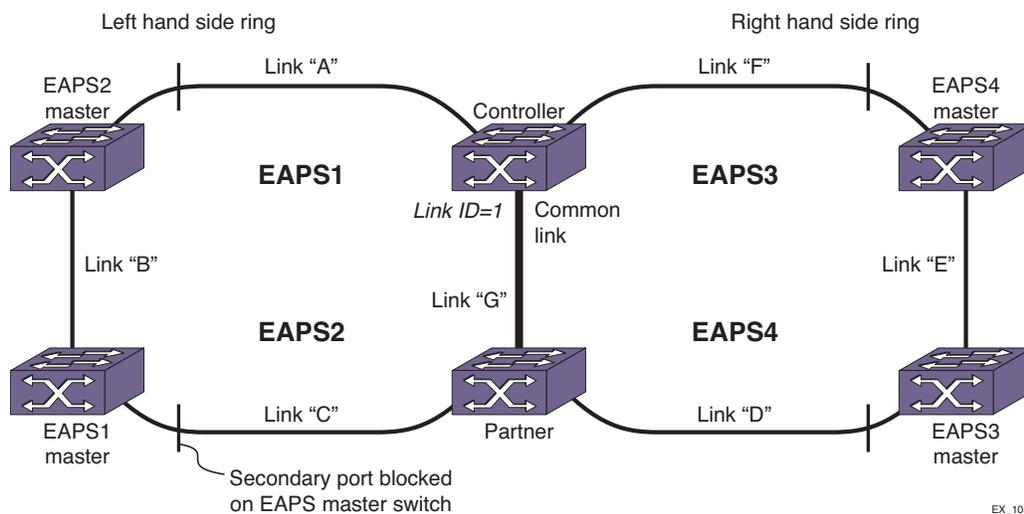
Controller and Partner Node States. EAPS controller and partner nodes can be in the following states:

- **Ready:** Indicates that the EAPS domains are running, the common-link neighbor can be reached through segment health-checks, and the common link is up.
- **Blocking:** Indicates that the EAPS domains are running, the common-link neighbor can be reached through segment health-checks, but the common-link is down. Only the controller node (and not the partner) performs blocking.
- **Preforwarding:** Indicates the EAPS domain was in a blocking state, and the common link was restored. The controller port is temporarily blocked to prevent a loop during state transition from *Blocking* to *Ready*.
- **Idle:** Indicates the EAPS common-link neighbor cannot be reached through segment health-check messages.

Spatial Reuse with an EAPS Common Link

The common-link topology supports multiple EAPS domains (spatial reuse) on each ring as shown in Figure 119.

Figure 119: EAPS Common Link Topology with Spatial Reuse



NOTE

If you are using the older method of enabling STP instead of EAPsv2 to block the super loop in a shared-port environment, you can continue to do so. In all other scenarios, Extreme Networks recommends that you do not use both STP and EAPS on the same port.

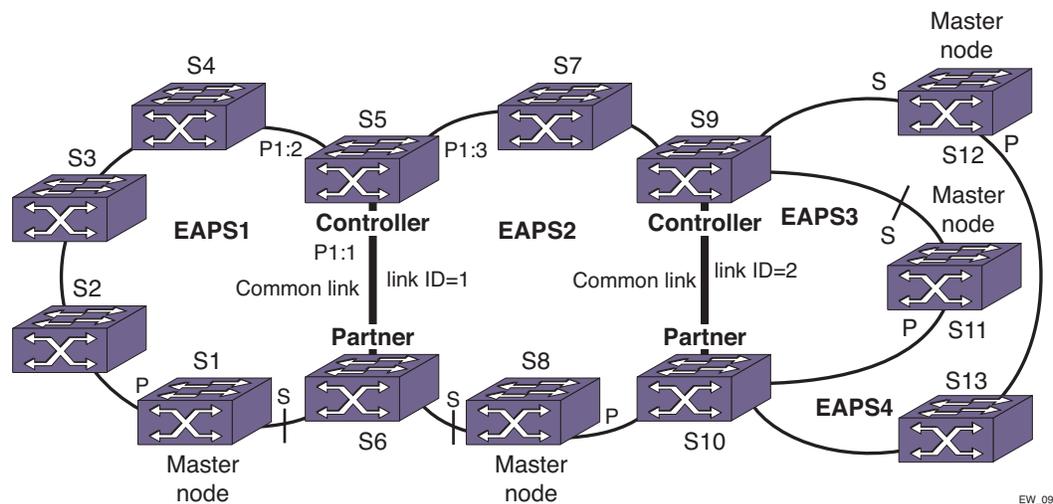
Additional Common Link Topology Examples

This section provides the following common link topology examples:

- [Basic Core Topology on page 947](#)
- [Right Angle Topology on page 947](#)
- [Combined Basic Core and Right Angle Topology on page 948](#)
- [Large Core and Access Ring Topology on page 949](#)

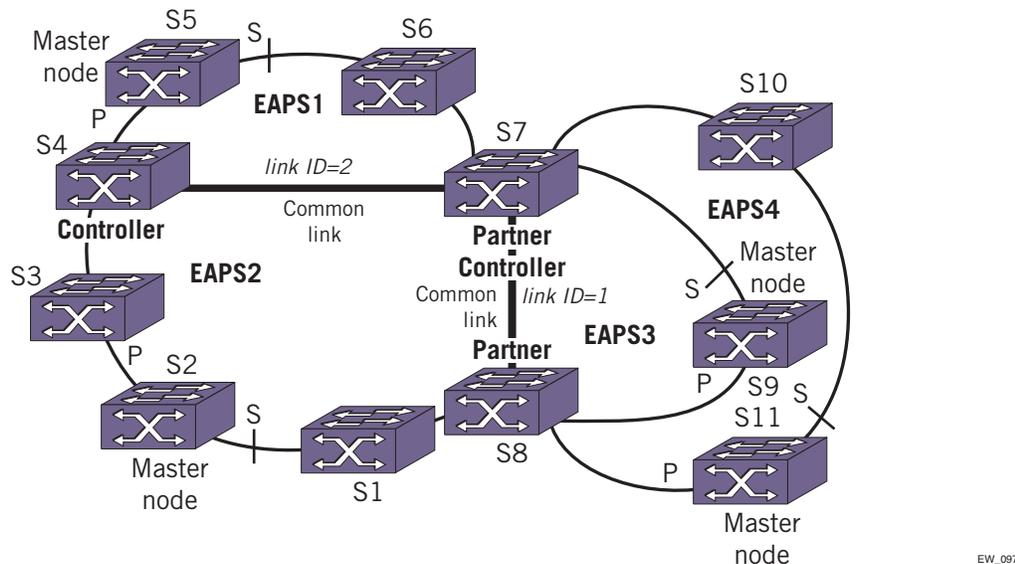
Basic Core Topology. Figure 120, shows a core topology with two access rings. In this topology, there are two EAPS common links.

Figure 120: Basic Core Topology



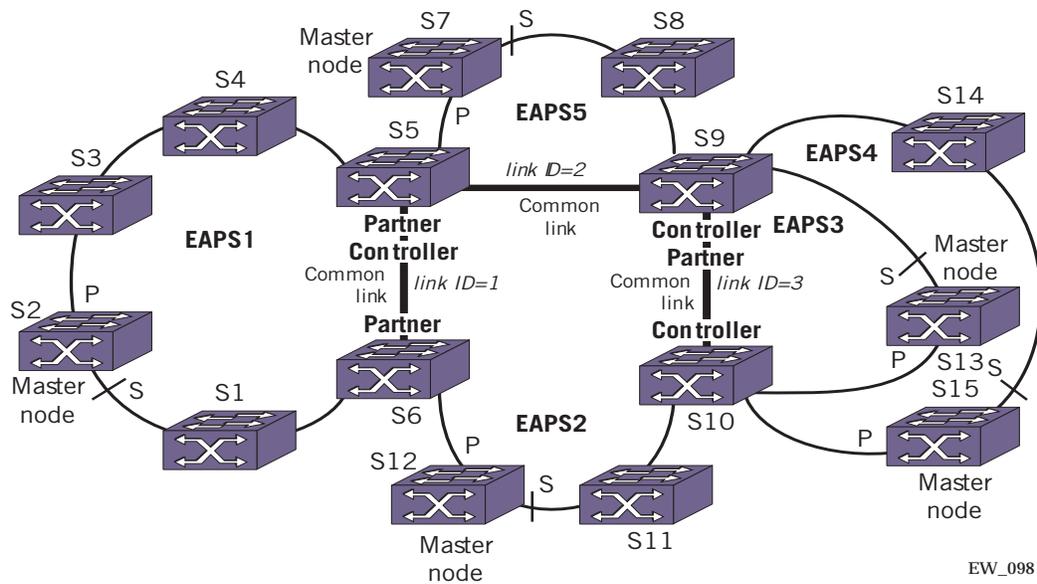
Right Angle Topology. In the right angle topology, there are still two EAPS common links, but the common links are adjacent to each other. To configure a right angle topology, there must be two common links configured on one of the switches. Figure 121 shows a right angle topology.

Figure 121: Right Angle Topology



Combined Basic Core and Right Angle Topology. Figure 122 shows a combination basic core and right angle topology.

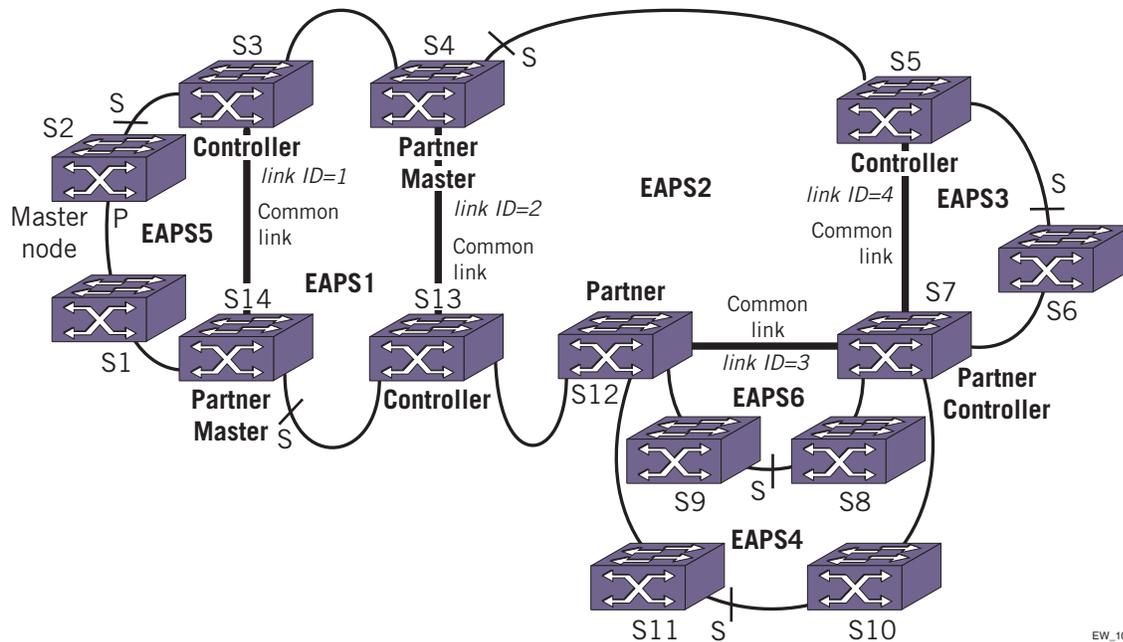
Figure 122: Basic Core and Right Angle Topology



EW_098

Figure 123 shows an extension of the basic core and right angle configuration.

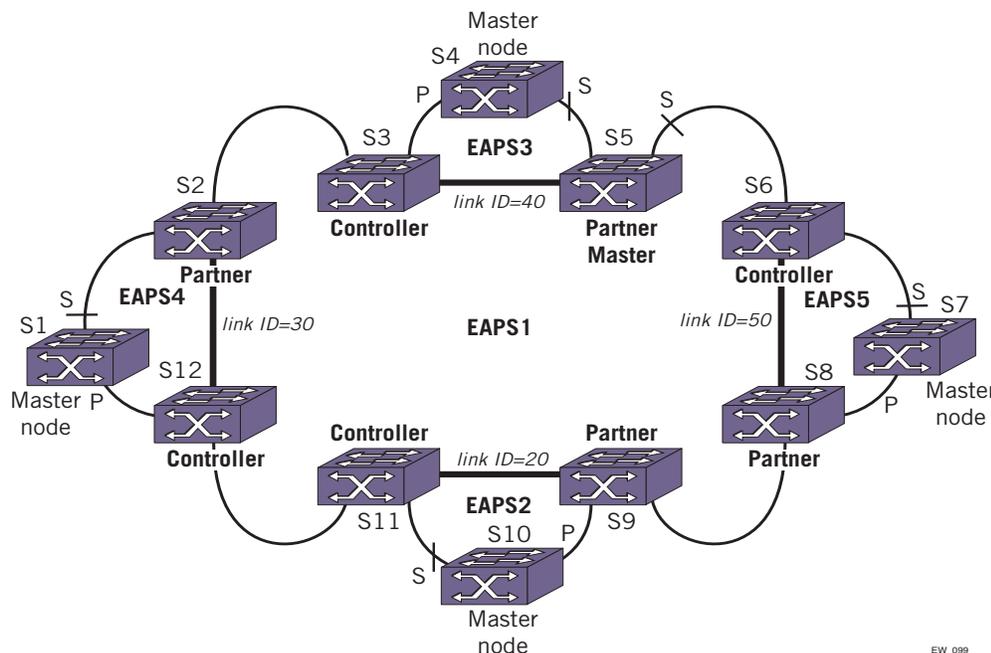
Figure 123: Advanced Basic Core and Right Angle Topology



EW_101

Large Core and Access Ring Topology. Figure 124 shows a single large core ring with multiple access rings hanging off of it. This is an extension of a basic core configuration.

Figure 124: Large Core and Access Ring Topology



Fast Convergence

The *fast convergence mode* allows EAPS to converge more rapidly. In EAPS fast convergence mode, the link filters on EAPS ring ports are turned off. In this case, an instant notification is sent to the EAPS process if a port's state transitions from *up* to *down* or vice-versa.

You configure fast convergence for the entire switch, not by EAPS domain.

EAPS and Hitless Failover—Modular Switches and SummitStack Only

When you install two Management Switch Fabric Modules (MSMs) or Management Modules (MMs) in a BlackDiamond chassis or use redundancy in a SummitStack, one MSM/MM (node) assumes the role of primary and another node assumes the role of backup. The primary executes the switch's management functions, and the backup acts in a standby role. Hitless failover transfers switch management control from the primary to the backup and maintains the state of EAPS. EAPS supports hitless failover. You do not explicitly configure hitless failover support; rather, if you have two MSMs/MMs installed in a chassis or you are operating with redundancy in a SummitStack, hitless failover is available.



NOTE

Not all platforms support hitless failover in the same software release. To verify if the software version you are running supports hitless failover, see [Table 15](#) in [Chapter 2, "Managing the Switch."](#) For more information about

protocol, platform, and MSM/MM support for hitless failover, see [“Understanding Hitless Failover Support—Modular Switches and SummitStack Only”](#) in Chapter 2, “Managing the Switch.”

To support hitless failover, the primary node replicates all EAPS protocol data units (PDUs) to the backup, which allows the backup to be aware of the EAPS domain state. Since both nodes receive EAPS PDUs, each node maintains equivalent EAPS states.

By knowing the state of the EAPS domain, the EAPS process running on the backup node can quickly recover after a primary node failover. Although both nodes receive EAPS PDUs, only the primary transmits EAPS PDUs to neighboring switches and actively participates in EAPS.

**NOTE**

For instructions on how to manually initiate hitless failover, see [“Relinquishing Primary Status”](#) on page 82.

EAPS Licensing

Different EAPS features are offered at different license levels. For complete information about software licensing, including how to obtain and upgrade your license and what licenses are appropriate for these features, see [Appendix A, “Feature License Requirements.”](#)

Configuring EAPS

This section describes the following topics:

- [Single Ring Configuration Tasks on page 950](#)
- [Common Link Topology Configuration Tasks on page 957](#)
- [Clearing the EAPS Counters on page 960](#)

Single Ring Configuration Tasks

This section describes the following topics:

- [Single Ring Configuration Overview on page 951](#)
- [Creating and Deleting an EAPS Domain on page 951](#)
- [Adding the EAPS Control VLAN on page 951](#)
- [Adding Protected VLANs on page 952](#)
- [Configuring the EAPS Domain Priority on page 952](#)
- [Defining the Switch Mode \(Master or Transit\) on page 953](#)
- [Configuring the Ring Ports on page 953](#)
- [Configuring the Polling Timers and Timeout Action on page 954](#)
- [Enabling and Disabling EAPS on the Switch on page 954](#)
- [Enabling and Disabling Fast Convergence on page 955](#)
- [Enabling and Disabling an EAPS Domain on page 955](#)
- [Configuring EAPS Support for Multicast Traffic on page 956](#)

- [Unconfiguring an EAPS Ring Port on page 956](#)
- [Disabling EAPS Loop Protection Warning Messages on page 957](#)

Single Ring Configuration Overview

To configure and enable an EAPS protected ring, do the following on each ring node:

- 1 Create an EAPS domain and assign a name to the domain as described in [“Creating and Deleting an EAPS Domain” on page 951](#).
- 2 Create and add the control VLAN to the domain as described in [“Adding the EAPS Control VLAN” on page 951](#).
- 3 Create and add the protected VLAN(s) to the domain as described in [“Adding Protected VLANs” on page 952](#).
- 4 Configure the EAPS mode (master or transit) for the switch in the domain as described in [“Defining the Switch Mode \(Master or Transit\)” on page 953](#).
- 5 Configure the EAPS ring ports, including the master primary and secondary ring ports, as described in [“Configuring the Ring Ports” on page 953](#).
- 6 If desired, configure the polling timers and timeout action as described in [“Configuring the Polling Timers and Timeout Action” on page 954](#).*
- 7 Enable EAPS for the entire switch as described in [“Enabling and Disabling EAPS on the Switch” on page 954](#).
- 8 If desired, enable Fast Convergence as described in [“Enabling and Disabling Fast Convergence” on page 955](#).*
- 9 Enable EAPS for the specified domain as described in [“Enabling and Disabling an EAPS Domain” on page 955](#).



NOTE

If you configure a VMAN on a switch running EAPS, make sure you configure the VMAN attributes on all of the switches that participate in the EAPS domain. For more information about VMANS, see the section [Chapter 13, “VMAN \(PBN\) and PBBN.”](#)

Creating and Deleting an EAPS Domain

Each EAPS domain is identified by a unique domain name.

To create an EAPS domain, use the following command:

```
create eaps <name>
```

To delete an EAPS domain, use the following command:

```
delete eaps <name>
```

Adding the EAPS Control VLAN

You must create and configure one *control* VLAN for each EAPS domain.

For instructions on creating a VLAN, see [Chapter 12, “VLANs.”](#) To configure EAPS to use a VLAN as the EAPS control VLAN for a domain, use the following command:

```
configure eaps <name> add control {vlan} <vlan_name>
```

**NOTE**

A control VLAN cannot belong to more than one EAPS domain. If the domain is active, you cannot delete the domain or modify the configuration of the control VLAN.

**NOTE**

The control VLAN must NOT be configured with an IP address. In addition, only ring ports may be added to this control VLAN. No other ports can be members of this VLAN. Failure to observe these restrictions can result in a loop in the network.

**NOTE**

The ring ports of the control VLAN must be tagged.

By default, EAPS PDUs are automatically assigned to QoS profile QP8. This ensures that the control VLAN messages reach their intended destinations. You do not need to configure a QoS profile for the control VLAN.

Adding Protected VLANs

You must add one or more protected VLANs to each EAPS domain. The protected VLANs are the data-carrying VLANs.

**NOTE**

When you configure a protected VLAN, the ring ports of the protected VLAN must be tagged (except in the case of the default VLAN).

For instructions on creating a VLAN, see [Chapter 12, “VLANs.”](#) To configure a VLAN as an EAPS protected VLAN, use the following command:

```
configure eaps <name> add protected {vlan} <vlan_name>
```

Configuring the EAPS Domain Priority

The EAPS domain priority feature allows you to select the EAPS domains that are serviced first when a break occurs in an EAPS ring. For example, you might set up a network topology with two or more domains on the same physical ring, such as in spatial reuse. In this topology, you could configure one domain as *high* priority and the others as *normal* priority. You would then add a small subset of the total protected vlans to the high priority domain, and add the rest of the protected vlans to the normal priority domain. The secondary port of the normal and high priority domains can be the same, or as is typically the case of spatial reuse, opposite. If a ring fault occurs in this topology, the protected VLANs in the high priority domain are the first to recover.

To configure the EAPS domain priority, use the following command:

```
configure eaps <name> priority {high | normal}
```

Defining the Switch Mode (Master or Transit)

To configure the EAPS switch mode for a domain, use the following command:

```
configure eaps <name> mode [master | transit]
```

One switch on the ring *must* be configured as the master node for the specified domain; all other switches on the same ring and domain are configured as transit nodes.

If you configure a switch to be a transit node for an EAPS domain, the default switch configuration displays the following message and prompts you to confirm the command:

```
WARNING: Make sure this specific EAPS domain has a Master node in the ring. If
you change this node from EAPS master to EAPS transit, you could cause a loop in the
network.
```

```
Are you sure you want to change mode to transit? (y/n)
```

When prompted, do one of the following:

- Enter `y` to identify the switch as a transit node.
- Enter `n` or press [Return] to cancel the command.

Extreme Networks recommends that you keep the loop protection warning messages enabled. If you have considerable knowledge and experience with EAPS, you might find the EAPS loop protection warning messages unnecessary. For more information see, [“Disabling EAPS Loop Protection Warning Messages” on page 957](#).

Configuring the Ring Ports

Each node on the ring connects to the ring through two ring ports. The ports that you choose on each switch should be tagged and added to the control VLAN and all protected VLANs. For information on adding tagged ports to a VLAN, see [Chapter 12, “VLANs.”](#)

On the master node, one ring port must be configured as the *primary* port, and the other must be configured as the *secondary* port. To configure a node port as primary or secondary, use the following command:

```
configure eaps <name> [primary | secondary] port <ports>
```

If you attempt to add an EAPS ring port to a VLAN that is not protected by EAPS, the default switch configuration prompts you to confirm the command with the following message:

```
Make sure <vlan_name> is protected by EAPS. Adding EAPS ring ports to a VLAN could
cause a loop in the network.
```

```
Do you really want to add these ports (y/n)
```

Enter `y` to add the ports to the VLAN. Enter `n` or press [Return] to cancel the command.

For information on configuring a VLAN for EAPS, see the following sections:

- [Adding the EAPS Control VLAN on page 951](#)
- [Adding Protected VLANs on page 952](#)

Extreme Networks recommends that you keep the loop protection warning messages enabled. If you have considerable knowledge and experience with EAPS, you might find the EAPS loop protection warning messages unnecessary. For more information see, [“Disabling EAPS Loop Protection Warning Messages” on page 957](#).

Configuring the Polling Timers and Timeout Action

The polling timers provide an alternate way to detect ring breaks. In a ring that uses only Extreme Networks switches, the master switch learns about a ring break by receiving a link-down PDU. When the ring uses only Extreme networks switches, the polling timers are not needed and can remain configured for the default values.

In a ring that contains switches made by other companies, the polling timers provide an alternate way to detect ring breaks. The master periodically sends hello PDUs at intervals determined by the hello PDU timer and waits for a reply. If a hello PDU reply is not received before the failtime timer expires, the switch detects a failure and responds by either sending an alert or opening the secondary port. The response action is defined by a configuration command.

To set the polling timer values the master node uses for detecting ring failures, use the following commands:

```
configure eaps <name> hellotime <seconds> <milliseconds>
configure eaps <name> failtime <seconds> <milliseconds>
```



NOTE

These commands apply only to the master node. If you configure the polling timers for a transit node, they are ignored. If you later reconfigure that transit node as the master node, the polling timer values are used as the current values.

Use the `hellotime` keyword and its associated parameters to specify the amount of time the master node waits between transmissions of health check messages on the control VLAN. The combined value for `seconds` and `milliseconds` must be greater than 0. The default value is 1 second.

Use the `failtime` keyword and its associated parameters to specify the amount of time the master node waits before the failtimer expires. The combined value for `seconds` and `milliseconds` must be greater than the configured value for `hellotime`. The default value is 3 seconds.



NOTE

Increasing the `failtime` value increases the time it takes to detect a ring break using the polling timers, but it can also reduce the possibility of incorrectly declaring a failure when the network is congested.

To configure the action taken when a ring break is detected, use the following command:

```
configure eaps <name> failtime expiry-action [open-secondary-port | send-alert]
```

Use the `send-alert` parameter to send an alert when the failtimer expires. Instead of going into a *failed* state, the master node remains in a *Complete* or *Init* state, maintains the secondary port blocking, and writes a critical error message to syslog warning the user that there is a fault in the ring. An SNMP trap is also sent.

Use the `open-secondary-port` parameter to open the secondary port when the failtimer expires.

Enabling and Disabling EAPS on the Switch

To enable the EAPS function for the entire switch, use the following command:

```
enable eaps
```

To disable the EAPS function for the entire switch, use the following command:

```
disable eaps
```

If you enter the command to disable EAPS, the default switch configuration displays the following warning message and prompts you to confirm the command:

```
WARNING: Disabling EAPS on the switch could cause a loop in the network!  
Are you sure you want to disable EAPS? (y/n)
```

When prompted, do one of the following:

- Enter `y` to disable EAPS for the entire switch.
- Enter `n` or press [Return] to cancel the command.

Extreme Networks recommends that you keep the loop protection warning messages enabled. If you have considerable knowledge and experience with EAPS, you might find the EAPS loop protection warning messages unnecessary. For more information see, [“Disabling EAPS Loop Protection Warning Messages” on page 957](#).

Enabling and Disabling Fast Convergence

You can enable or disable fast convergence for the entire switch. This feature ensures convergence in less than 50 milliseconds.

To enable or disable fast convergence on the switch, use the following command:

```
configure eaps fast-convergence [off | on]
```

Enabling and Disabling an EAPS Domain

To enable a specific EAPS domain, use the following command:

```
enable eaps {<name>}
```

To disable a specific EAPS domain, use the following command:

```
disable eaps {<name>}
```

If you enter the `disable eaps` command, the default switch configuration displays the following warning message and prompts you to confirm the command:

```
WARNING: Disabling specific EAPS domain could cause a loop in the network!  
Are you sure you want to disable this specific EAPS domain? (y/n)
```

When prompted, do one of the following:

- Enter `y` to disable EAPS for the specified domain.
- Enter `n` or press [Return] to cancel the command.

Extreme Networks recommends that you keep the loop protection warning messages enabled. If you have considerable knowledge and experience with EAPS, you might find the EAPS loop protection warning messages unnecessary. For more information see, [“Disabling EAPS Loop Protection Warning Messages” on page 957](#).

Configuring EAPS Support for Multicast Traffic

The ExtremeXOS software provides several commands for configuring how EAPS supports multicast traffic after an EAPS topology change. For more information, see the descriptions for the following commands:

- `configure eaps multicast add-ring-ports`
- `configure eaps multicast send-igmp-query`
- `configure eaps multicast temporary-flooding`



NOTE

EAPS multicast flooding must be enabled before the `add-ring-ports` feature will operate. For information on enabling EAPS multicast flooding, see the `configure eaps multicast temporary-flooding [on | off]` command description.

Unconfiguring an EAPS Ring Port

Unconfiguring an EAPS port sets its internal configuration state to INVALID, which causes the port to appear in the Idle state with a port status of Unknown when you use the `show eaps {<eapsDomain>} {detail}` command to display the status information about the port.

To unconfigure an EAPS primary or secondary ring port for an EAPS domain, use the following command:

```
unconfigure eaps <eapsDomain> [primary | secondary] port
```

To prevent loops in the network, the switch displays by default a warning message and prompts you to unconfigure the specified EAPS primary or secondary ring port. When prompted, do one of the following:

- Enter `y` to unconfigure the specified port.
- Enter `n` or press [Return] to cancel this action.

The following command example unconfigures this node's EAPS primary ring port on the domain "eaps_1":

```
unconfigure eaps eaps_1 primary port
```

```
WARNING: Unconfiguring the Primary port from the EAPS domain could cause a loop in the network!
```

```
Are you sure you want to unconfigure the Primary EAPS Port? (y/n)
```

Enter `y` to continue and unconfigure the EAPS primary ring port. Enter `n` to cancel this action.

The switch displays a similar warning message if you unconfigure the secondary EAPS port.

Extreme Networks recommends that you keep the loop protection warning messages enabled. If you have considerable knowledge and experience with EAPS, you might find the EAPS loop protection warning messages unnecessary. For more information see, "[Disabling EAPS Loop Protection Warning Messages](#)" on page 957.

Disabling EAPS Loop Protection Warning Messages

The switch displays by default loop protection messages when configuring the following EAPS parameters:

- Adding EAPS primary or secondary ring ports to a VLAN
- Deleting a protected VLAN
- Disabling the global EAPS setting on the switch
- Disabling an EAPS domain
- Configuring an EAPS domain as a transit node
- Unconfiguring EAPS primary or secondary ring ports from an EAPS domain

Extreme Networks recommends that you keep the loop protection warning messages enabled. If you have considerable knowledge and experience with EAPS, you might find the EAPS loop protection warning messages unnecessary. For example, if you use a script to configure your EAPS settings, disabling the warning messages allows you to configure EAPS without replying to each interactive yes/no question.

To disable loop protection messages, use the following command:

```
configure eaps config-warnings off
```

To re-enable loop protection messages, use the following command:

```
configure eaps config-warnings on
```

Common Link Topology Configuration Tasks

To create a common link topology, you must configure the shared ports at each end of the common link. This section describes the following topics:

- [EAPS Shared Port Configuration Rules on page 957](#)
- [Common Link Configuration Overview on page 958](#)
- [Creating and Deleting a Shared Port on page 958](#)
- [Defining the Mode of the Shared Port on page 959](#)
- [Configuring the Link ID of the Shared Port on page 959](#)
- [Configuring the Shared Port Timers and Timeout Action on page 959](#)
- [Unconfiguring an EAPS Shared Port on page 959](#)

EAPS Shared Port Configuration Rules

The following rules apply to EAPS shared port configurations:

- Each common link in the EAPS network must have a unique link ID, which is configured at the shared port at each end of the link.
- The shared port mode configured on each side of a common link must be different from the other; one must be a *controller* and one must be a *partner*.
- The controller and partner shared ports on either side of a common link *must* have the same link ID. The common link is established only when the shared ports at each end of the common link have the same link ID.
- There can be up to two shared ports per switch.

- There cannot be more than one controller on a switch.
Valid combinations on any one switch are:
 - 1 controller
 - 1 partner
 - 1 controller and 1 partner
 - 2 partners
- A shared port cannot be configured on an EAPS master's secondary port.

**NOTE**

When a common link fails, one of the segment ports becomes the active-open port, and all other segment ports are blocked to prevent a loop for the protected VLANs. For some topologies, you can improve network performance during a common link failure by selecting the port numbers to which segments connect. For information on how the active-open port is selected, see [“Common Link Fault Detection and Response” on page 943](#).

Common Link Configuration Overview

To configure and enable a common link to serve multiple rings, do the following on the controller and partner nodes:

- 1 Create a shared port for the common link as described in [“Creating and Deleting a Shared Port” on page 958](#).
- 2 Configure the shared port as either a controller or a partner as described in [“Defining the Mode of the Shared Port” on page 959](#).
- 3 Configure the link ID on the shared port as described in [“Configuring the Link ID of the Shared Port” on page 959](#).
- 4 If desired, configure the polling timers and timeout action as described in [“Configuring the Shared Port Timers and Timeout Action” on page 959](#).

This step can be configured at any time, even after the EAPS domains are running.

- 5 Configure EAPS on each ring as described in [“Single Ring Configuration Overview” on page 951](#).

Creating and Deleting a Shared Port

To configure a common link, you must create a shared port on each switch belonging to the common link. To create a shared port, use the following command:

```
create eaps shared-port <ports>
```

Where `ports` is the common link port.

**NOTE**

A switch can have a maximum of two shared ports.

To delete a shared port on the switch, use the following command:

```
delete eaps shared-port <ports>
```

Defining the Mode of the Shared Port

The shared port on one end of the common link must be configured to be the controller. This is the end responsible for blocking ports when the common link fails, thereby preventing the superloop.

The shared port on the other end of the common link must be configured to be the partner. This end does not participate in any form of blocking. It is responsible for only sending and receiving health-check messages.

To configure the mode of the shared port, use the following command:

```
configure eaps shared-port <ports> mode <controller | partner>
```

Configuring the Link ID of the Shared Port

Each common link in the EAPS network must have a unique link ID. The controller and partner shared ports that belong to the same common link must have *matching* link IDs. No other instance in the network should have that link ID.

If you have multiple adjacent common links, Extreme Networks recommends that you configure the link IDs in ascending order of adjacency. For example, if you have an EAPS configuration with three adjacent common links, moving from left to right of the topology, configure the link IDs from the lowest to the highest value.

To configure the link ID of the shared port, use the following command:

```
configure eaps shared-port <ports> link-id <id>
```

The link ID range is 1 to 65535.

Configuring the Shared Port Timers and Timeout Action

To configure the shared port timers, use the following commands:

```
configure eaps shared-port <port> common-path-timers {[health-interval | timeout]
<seconds>}
configure eaps shared-port <port> segment-timers health-interval <seconds>
configure eaps shared-port <port> segment-timers timeout <seconds>
```

To configure the time out action for segment timers, use the following command:

```
configure eaps shared-port <port> segment-timers expiry-action [segment-down | send-
alert]
```

Unconfiguring an EAPS Shared Port

To unconfigure a link ID on a shared port, use the following command:

```
unconfigure eaps shared-port <ports> link-id
```

To unconfigure the mode on a shared port, use the following command:

```
unconfigure eaps shared-port <ports> mode
```

To delete a shared port, use the following command:

```
delete eaps shared-port <ports>
```

Clearing the EAPS Counters

The EAPS counters continue to increment until you explicitly clear the information. By clearing the counters, you can see fresh statistics for the time period you are monitoring. To clear the counters used by EAPS, use one of the following commands:

- `clear counters`
- `clear eaps counters`

Displaying EAPS Information

This section describes the following tasks:

- [Displaying Single Ring Status and Configuration Information on page 960](#)
- [Displaying Domain Counter Information on page 960](#)
- [Displaying Common Link Status and Configuration Information on page 961](#)
- [Displaying Common Link Counter Information on page 961](#)

Displaying Single Ring Status and Configuration Information

To display EAPS status and configuration information, use the following command:

```
show eaps {<eapsDomain>} {detail}
```



NOTE

You might see a slightly different display, depending on whether you enter the command on the master node or the transit node.

If you specify a domain with the optional `eapsDomain` parameter, the command displays status information for a specific EAPS domain.

The display from the `show eaps detail` command shows all the information shown in the `show eaps <eapsDomain>` command for all configured EAPS domains.

Displaying Domain Counter Information

To display EAPS counter information for one or all domains, use the following command:

```
show eaps counters [<eapsDomain> | global]
```

If you specify the name of an EAPS domain, the switch displays counter information related to only that domain.

If you specify the `global` keyword, the switch displays a list of the counter totals for all domains. To see the counters for a specific domain, you must specify the domain name.

**NOTE**

If a PDU is received, processed, and consumed, only the Rx counter increments. If a PDU is forwarded in slow path, both the Rx counter and Fw counter increment.

Displaying Common Link Status and Configuration Information

Each controller and partner node can display status and configuration information for the shared port or ports on the corresponding side of the common link. To display EAPS common link information, use the following command:

```
show eaps shared-port {<port>} {detail}
```

If you enter the `show eaps shared-port` command without an argument or keyword, the command displays a summary of status information for all configured EAPS shared ports on the switch.

If you specify a shared port, the command displays information about that specific port.

You can use the `detail` keyword to display more detailed status information about the segments and VLANs associated with each shared port.

Displaying Common Link Counter Information

Each controller and partner node can display counter information for the shared port or ports through which the switch connects to a common link. To display EAPS shared port counter information, use the following command:

```
show eaps counters shared-port [global | <port> {segment-port <segport>
{<eapsDomain>}}]
```

If you specify the `global` keyword, the switch displays a list of counters that show the totals for all shared ports together. To view the counters for a single shared port, enter the command with the port number.

If you specify a particular EAPS segment port, the switch displays counter information related to only that segment port for the specified EAPS domain.

Configuration Examples

This section provides the following examples:

- [Migrating from STP to EAPS on page 962](#)
- [Designing and Implementing a Highly Resilient Enterprise Network Using EAPS on page 965](#)
- [Example EAPS and PBB Configuration on page 989](#)

Migrating from STP to EAPS

This section explains how to migrate or reconfigure an existing STP network to an EAPS network.

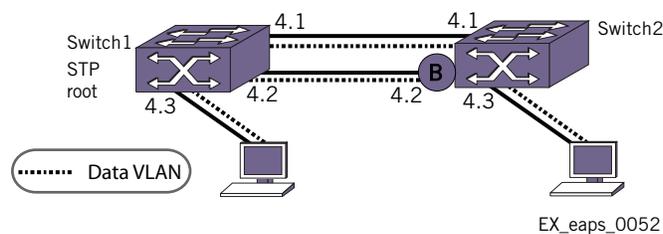


NOTE

Actual implementation steps on a production network may differ based on the physical topology, switch models, and software versions deployed.

The sample STP network is a simple two switch topology connected with two Gigabit Ethernet trunk links, which form a broadcast loop. Both Extreme Networks switches are configured for 802.1D mode STP running on a single data VLAN named *Data*. The sample STP network for migration to EAPS is shown in [Figure 125](#).

Figure 125: Sample STP Network for Migration to EAPS



The following sections describe the tasks required to migrate from STP to EAPS:

- 1 [Creating and Configuring the EAPS Domain on page 962](#)
- 2 [Creating and Configuring the EAPS Control VLAN on page 963](#)
- 3 [Enabling EAPS and Verifying EAPS Status on page 963](#)
- 4 [Configuring the STP Protected VLAN as an EAPS Protected VLAN on page 963](#)
- 5 [Verifying the EAPS Blocking State for the Protected VLAN on page 964](#)
- 6 [Verifying the STP Status and Disabling STP on page 964](#)

Creating and Configuring the EAPS Domain

The first step in the migration process is to create an EAPS Domain and configure the EAPS mode, then define the primary and secondary ports for the domain. Follow this step for both switches. Switch2 is configured as EAPS Master to ensure the same port blocking state is maintained as in the original STP topology.

Switch 1 EAPS domain configuration:

```
* SWITCH#1.1 # create eaps new-eaps
* SWITCH#1.2 # configure new-eaps mode transit
* SWITCH#1.3 # configure new-eaps primary port 4:1
* SWITCH#1.4 # configure new-eaps secondary port 4:2
```

Switch 2 EAPS domain configuration:

```
* SWITCH#2.1 # create eaps new-eaps
* SWITCH#2.2 # configure new-eaps mode master
* SWITCH#2.3 # configure new-eaps primary port 4:1
* SWITCH#2.4 # configure new-eaps secondary port 4:2
```

Creating and Configuring the EAPS Control VLAN

You must create the EAPS control VLAN and configure the 802.1q tag, and ring ports. Then you configure the control VLANs as part of the EAPS domain. Do this for both switches.

Switch 1 control VLAN configuration:

```
* SWITCH#1.5 # create vlan control-1
* SWITCH#1.6 # configure vlan control-1 tag 4001
* SWITCH#1.8 # configure vlan control-1 add port 4:1,4:2 tagged
* SWITCH#1.9 # configure eaps new-eaps add control vlan control-1
```

Switch 2 control VLAN configuration:

```
* SWITCH#2.5 # create vlan control-1
* SWITCH#2.6 # configure vlan control-1 tag 4001
* SWITCH#2.8 # configure vlan control-1 add port 4:1,4:2 tagged
* SWITCH#2.9 # configure eaps new-eaps add control vlan control-1
```

Enabling EAPS and Verifying EAPS Status

Enable the EAPS protocol and the EAPS domain. Then confirm that the master node is in *Complete* state and its secondary port is blocking.

Switch 1 commands to enable EAPS and the domain:

```
* SWITCH#1.10 # enable eaps
* SWITCH#1.11 # enable eaps new-eaps
```

Switch 2 commands to enable EAPS and verify status:

```
* SWITCH#2.10 # enable eaps
* SWITCH#2.11 # enable eaps new-eaps
* SWITCH#2.12 # show eaps
```

```
EAPS Enabled: Yes
EAPS Fast-Convergence: Off
EAPS Display Config Warnings: On
EAPS Multicast Add Ring Ports: Off
EAPS Multicast Send IGMP Query: On
EAPS Multicast Temporary Flooding: Off
EAPS Multicast Temporary Flooding Duration: 15 sec
Number of EAPS instances: 1
# EAPS domain configuration :
```

Domain	State	Mo	En	Pri	Sec	Control-Vlan	VID	Count
new-eaps	Complete	M	Y	4:1	4:2	control-1	(4001)	0

Configuring the STP Protected VLAN as an EAPS Protected VLAN

Configure the *data* VLAN (currently protected by STP as an untagged VLAN) as an EAPS protected VLAN. Assign an 802.1q tag to the *data* VLAN, as this might not be required with the previous STP configuration. Next, the *data* VLAN is added to the EAPS domain as a protected VLAN. Configure the VLAN port changes at the end to prevent any broadcast loop from forming during the transition from STP to EAPS protection. A warning message is displayed on the CLI, but this can be ignored, as it is

just a reminder that the ring ports have not been added to the protected VLAN yet. Finish this step by changing the port membership for the *data* VLAN from untagged to 802.1q tagged trunk ports.

Switch#2 commands to add EAPS protected VLAN and tagged ports:

```
* SWITCH#2.13 # configure vlan data tag 1000
* SWITCH#2.14 # configure new-eaps add protect vlan data
WARNING: Primary port [4:1] is not tagged on vlan "data", EAPS="new-eaps"
WARNING: Secondary port [4:2] is not tagged on vlan "data", EAPS="new-eaps"
* SWITCH#2.15 # configure data add port 4:1,4:2 tagged
```

Switch#1 commands to add EAPS protected VLAN and tagged ports:

```
* SWITCH#1.13 # configure vlan data tag 1000
* SWITCH#1.14 # configure new-eaps add protect vlan data
WARNING: Primary port [4:1] is not tagged on vlan "data", EAPS="new-eaps"
WARNING: Secondary port [4:2] is not tagged on vlan "data", EAPS="new-eaps"
* SWITCH#1.15 # configure data add port 4:1,4:2 tagged
```

Verifying the EAPS Blocking State for the Protected VLAN

To ensure there is no potential for a broadcast storm, confirm that EAPS is successfully blocking the protected VLAN as shown in the following example:

```
* SWITCH#2.16 # show new-eaps

Name: new-eaps
State: Complete                               Running: Yes
Enabled: Yes Mode: Master
Primary port: 4:1          Port status: Up          Tag status: Tagged
Secondary port: 4:2       Port status: Blocked    Tag status: Tagged
Hello timer interval: 1 sec 0 millisecc
Fail timer interval: 3 sec
Fail Timer expiry action: Send alert
Last valid EAPS update: From Master Id 00:04:96:10:51:50, at Fri Sep 10 13:38:39
2004
EAPS Domain's Controller Vlan: control-1 4001
EAPS Domain's Protected Vlan(s): data 1000
Number of Protected Vlans: 1
```

After you verify that EAPS is protecting the Data VLAN, you can safely remove the STP configuration.

Verifying the STP Status and Disabling STP

Once you have successfully verified that EAPS has taken over loop prevention for the *data* VLAN, you no longer need the STP configuration. Now, verify whether the *data* VLAN is removed from the STP domain, and then disable the STP protocol.

Switch 2 commands to verify STP status and disable STP:

```
* SWITCH#2.17 # show stp s0
Stpd: s0                               Stp: ENABLED           Number of Ports: 0
Rapid Root Failover: Disabled
Operational Mode: 802.1D                Default Binding Mode: 802.1D
802.1Q Tag: (none)
Ports: (none)
```

```

Participating Vlans: (none)
Auto-bind Vlans: Default
Bridge Priority: 32768
BridgeID:          80:00:00:04:96:10:51:50
Designated root:  80:00:00:04:96:10:51:50
RootPathCost: 0   Root Port: ----
MaxAge: 20s       HelloTime: 2s       ForwardDelay: 15s
CfgBrMaxAge: 20s  CfgBrHelloTime: 2s      CfgBrForwardDelay: 15s
Topology Change Time: 35s           Hold time: 1s
Topology Change Detected: FALSE      Topology Change: FALSE
Number of Topology Changes: 4
Time Since Last Topology Change: 1435s
* SWITCH#2.18 # show s0 port
Port Mode State Cost Flags Priority Port ID Designated Bridge
* SWITCH#2.19 # disable stp

```

Switch 1 commands to verify STP status and disable STP:

```

* SWITCH#1.16 # show stp s0
Stpd: s0                Stp: ENABLED                Number of Ports: 0
Rapid Root Failover: Disabled
Operational Mode: 802.1D           Default Binding Mode: 802.1D
802.1Q Tag: (none)
Ports: (none)
Participating Vlans: (none)
Auto-bind Vlans: Default
Bridge Priority: 1
BridgeID:          00:01:00:04:96:10:30:10
Designated root:  00:01:00:04:96:10:30:10
RootPathCost: 0   Root Port: ----
MaxAge: 20s       HelloTime: 2s       ForwardDelay: 15s
CfgBrMaxAge: 20s  CfgBrHelloTime: 2s      CfgBrForwardDelay: 15s
Topology Change Time: 35s           Hold time: 1s
Topology Change Detected: FALSE      Topology Change: FALSE
Number of Topology Changes: 2
Time Since Last Topology Change: 11267s
* SWITCH#1.17 # show stp s0 po
Port Mode State Cost Flags Priority Port ID Designated Bridge
* SWITCH#1.18 # disable stp s0
* SWITCH#1.19 # disable stp

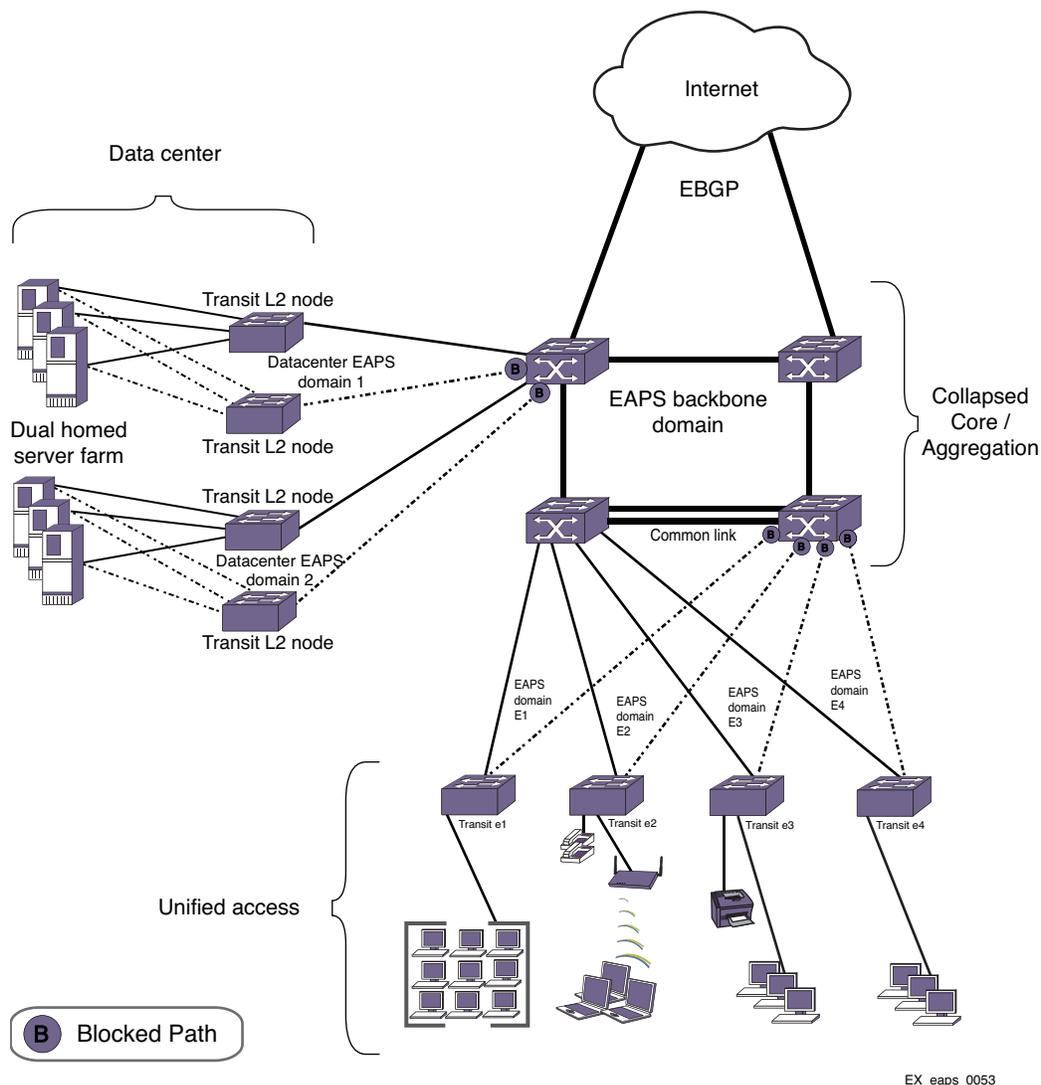
```

The network should now be successfully migrated from STP to EAPS.

Designing and Implementing a Highly Resilient Enterprise Network Using EAPS

Network managers can design and employ a highly resilient end-to-end enterprise network using the Extreme Networks switching platform and the EAPS protocol as shown in [Figure 126](#).

Figure 126: Extreme Networks EAPS Everywhere



EAPS can be used in the network edge to provide link resiliency for Ethernet and IP services in a partial-meshed design. In the aggregation layer, EAPS interconnects multiple edge and core domains. When combined with VRRP and OSPF in the aggregation layer, EAPS provides the foundation for highly resilient IP routing by protecting against link and switch failures.

In the network core, EAPS is used with OSPF to provide a high-performance IP routing backbone with zero downtime or route flaps. Using EAPS and dual-homed server farms in the datacenter provides high availability for mission-critical server resources.

The collapsed core/aggregation layer and datacenter also make use of EAPS resilient ring topology to ensure network availability to all critical sources.

The following sections provide additional information on this example:

- [Designing and Configuring the Unified Access Layer on page 967](#)
- [Designing and Configuring the Aggregation Layer on page 969](#)
- [Designing and Configuring L3 Services on Top of EAPS on page 974](#)

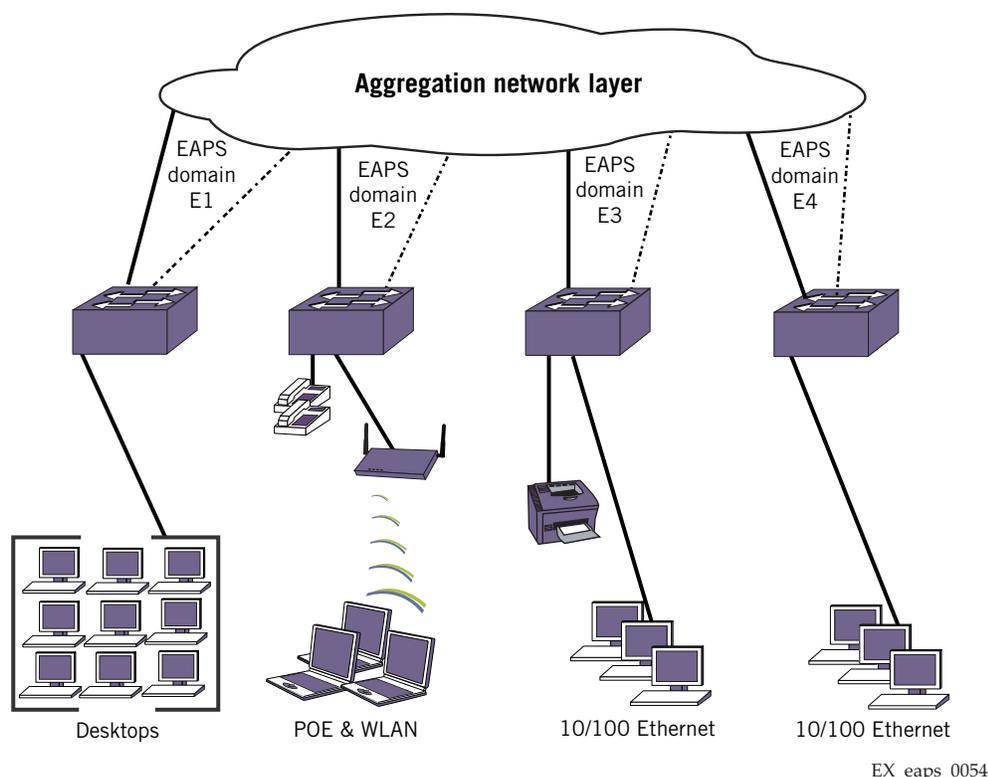
- [Designing and Configuring the Core Layer with EAPS on page 978](#)
- [Designing and Configuring the Datacenter Switches with EAPS on page 984](#)

Designing and Configuring the Unified Access Layer

The unified access network layer makes use of EAPS in a partial-meshed ring topology for maximum resiliency. The edge of the network is the first point of entry for client devices such as PCs, servers, VoIP phones, wireless devices, and printers.

Utilizing EAPS and redundant uplink ports on edge switches increases network resiliency and availability. Edge switches connect their primary and secondary uplink trunk ports to one or more switches in the aggregation network layer (as shown in [Figure 127](#)). If the primary uplink port fails, traffic can use the alternate secondary uplink.

Figure 127: Converged Network Edge (Unified Access Layer)



In this sample network, each edge switch is configured with a unique EAPS domain and control VLAN. Protected VLANs can overlap across multiple EAPS domains, or remain local to their own domain.

By putting each edge switch and VLAN into a separate EAPS domain, you gain resiliency and management benefits. First, any link or switch failures in one ring do not affect the other edge switches. Also, this type of modular design allows you to add edge switches easily without impacting other parts of the network. Troubleshooting becomes easier as the scope of failures can be quickly isolated to a specific EAPS ring or switch.

This section describes how to design the access edge network switches as EAPS transit nodes to provide Ethernet L2 connectivity services. In this example, upstream aggregation switches perform Layer 3 (L3)

inter-VLAN routing functions. Although not discussed in the scope of this section, the edge switches could also be configured with additional routing, QoS, WLAN, or security features.

To configure the L2 edge switches, complete the tasks described in the following sections on all network edge switches:

- 1 [Creating and Configuring the EAPS Domain on page 968](#)
- 2 [Creating and Configuring the EAPS Control VLAN on page 968](#)
- 3 [Creating and Configuring EAPS Protected VLANs on page 968](#)
- 4 [Enabling the EAPS Protocol and EAPS Domain on page 968](#)
- 5 [Verifying the EAPS Configuration and Status on page 968](#)

Creating and Configuring the EAPS Domain. Create the EAPS domain, configure the switch as a transit node, and define the EAPS primary and secondary ports as shown in the following example:

```
* Edge-Switch#1:1 # create eaps e1-domain
* Edge-Switch#1:2 # configure eaps e1-domain mode transit
* Edge-Switch#1:3 # configure eaps e1-domain primary port 49
* Edge-Switch#1:4 # configure eaps e1-domain secondary port 50
```

Creating and Configuring the EAPS Control VLAN. Create the EAPS control VLAN and configure its 802.1q tag, and ring ports. Next, configure the control VLAN as part of the EAPS domain. The control VLAN only contains the EAPS primary and secondary ports configured earlier. The following commands accomplish these tasks:

```
* Edge-Switch#1:5 # create vlan control-1
* Edge-Switch#1:6 # configure vlan control-1 tag 4000
* Edge-Switch#1:8 # configure vlan control-1 add port 49,50 tagged
* Edge-Switch#1:9 # configure eaps e1-domain add control vlan control-1
```

Creating and Configuring EAPS Protected VLANs. Create at least one EAPS protected VLAN, and configure its 802.1q tag and ports. Next, configure the protected VLAN as part of the EAPS domain. The *Protect* VLAN contains the EAPS primary and secondary ports as tagged VLAN ports. Additional VLAN ports connected to client devices such as a PC could be untagged or tagged. The following commands accomplish these tasks and should be repeated for all additional protected VLANs:

```
* Edge-Switch#1:10 # create vlan purple-1
* Edge-Switch#1:11 # configure purple-1 tag 1
* Edge-Switch#1:12 # configure purple-1 add port 49,50 tagged
* Edge-Switch#1:13 # configure purple-1 add port 1 untagged
* Edge-Switch#1:14 # configure eaps e1-domain add protect vlan purple-1
```

Enabling the EAPS Protocol and EAPS Domain. Enable EAPS to run on the domain as shown in the following example:

```
* Edge-Switch#1:15 # enable eaps
* Edge-Switch#1:16 # enable eaps e1-domain
```

Verifying the EAPS Configuration and Status. The command in the following example allows you to verify that the EAPS configuration is correct and that the EAPS state is *Links-Up*. Both ring ports must be plugged in to see the *Links-Up* state.

```
* Edge-Switch#1:17 # show eaps e1-domain detail

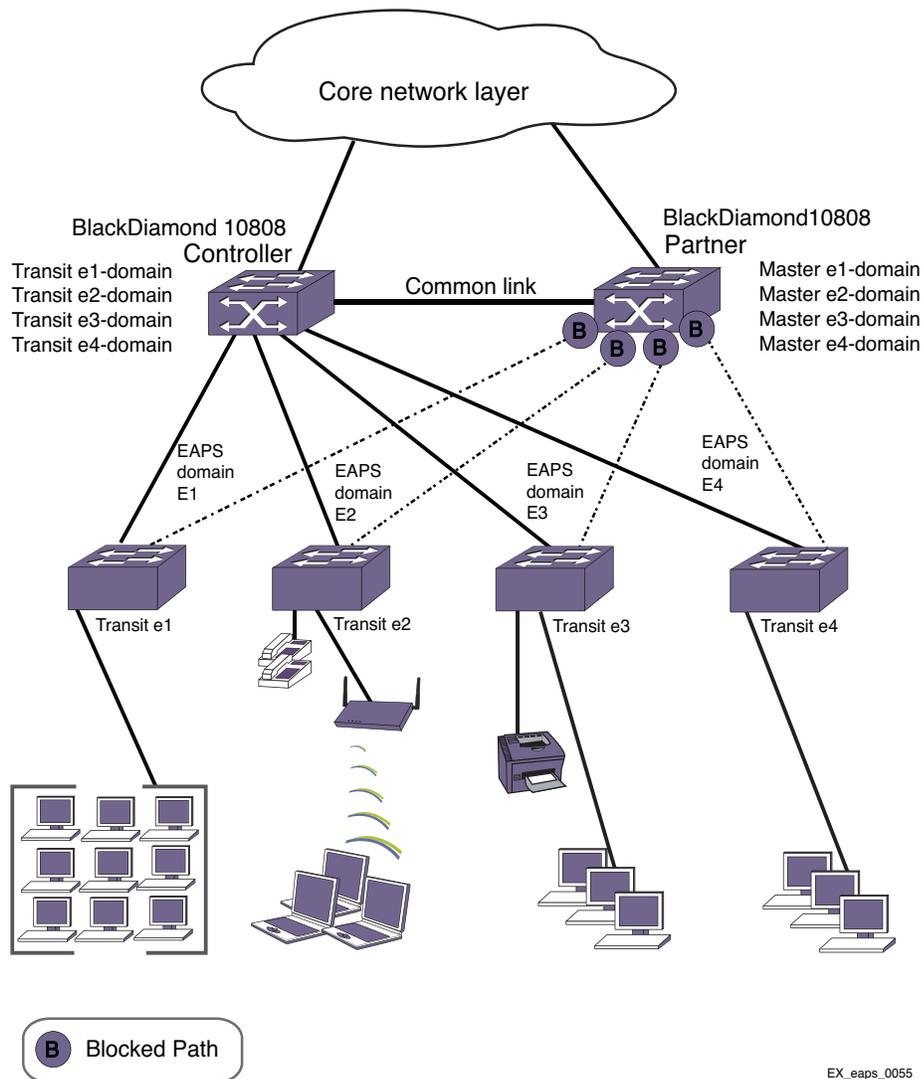
Name: "e1-domain" (instance=0) Priority: High
State: Links-Up                      Running: Yes
Enabled: Yes                          Mode: Transit
```

```
Primary port: 49          Port status: Up          Tag status: Tagged
Secondary port: 50       Port status: Up          Tag status: Tagged
Hello Timer interval: 1 sec 0 millise
Fail Timer interval: 3 sec
Preforwarding Timer interval: 0 sec
Last valid EAPS update: From Master Id 00:04:96:10:51:50, at Sun Sep 5 23:20:10 2004
EAPS Domain has following Controller Vlan:
  Vlan Name          VID
  "control-1"       4000
EAPS Domain has following Protected Vlan(s):
  Vlan Name          VID
  "purple-1"        0001
Number of Protected Vlans: 1
```

Designing and Configuring the Aggregation Layer

The network switches in the aggregation layer provide additional resiliency benefits. As in this example, aggregation switches are typically deployed in pairs that protect against single switch failures. Each aggregation switch is physically connected to all edge switches and participates in multiple EAPS domains. The aggregation switches can serve a different role within each EAPS domain, with one switch acting as a transit node and the other as a master node. In this example, we have a common link with overlapping domains (and protected VLANs) which includes an EAPS controller and partner configuration. The result is a *partial-mesh* network design of EAPS from the access edge to the aggregation layer (see [Figure 128](#)).

Figure 128: L2 Aggregation Network Layer



The aggregation switches are configured to act as multi-function EAPS nodes to provide L2 connectivity services. After EAPS and L2 connectivity is configured additional L3 routing configuration can be added.

Using redundant aggregation switches helps protect against a single point of failure at the switch level, while EAPS domains provide fault isolation and minimize the impact that failures have on the network. With shared port configurations, the partial-mesh physical design is maintained without broadcast loops, regardless of where a failure might occur.

To configure the L2 aggregate switches, complete the tasks described in the following sections on all aggregate switches:

- 1 [Creating and Configuring the EAPS Domains on page 971](#)
- 2 [Creating and Configuring the EAPS Control VLANs on page 972](#)
- 3 [Creating and Configuring the EAPS Shared Ports on page 972](#)
- 4 [Enabling the EAPS Protocol and EAPS Domain on page 972](#)
- 5 [Creating and Configuring the EAPS Protected VLANs on page 972](#)
- 6 [Verifying the EAPS Configuration and Operating State on page 973](#)

Creating and Configuring the EAPS Domains. Create the EAPS domains for each ring (1 domain for one edge switch) and configure the EAPS mode. Define the primary and secondary ports for each domain; but, in this example, the primary port is the same as the common link. One aggregation switch has EAPS mode configured as master and partner, while the other aggregation switch is configured as transit and controller.

EAPS master node configuration:

```
* AGG-SWITCH#2.1 # create eaps e1-domain
* AGG-SWITCH#2.2 # create eaps e2-domain
* AGG-SWITCH#2.3 # create eaps e3-domain
* AGG-SWITCH#2.4 # create eaps e4-domain
* AGG-SWITCH#2.5 # configure eaps e1-domain mode master
* AGG-SWITCH#2.6 # configure eaps e2-domain mode master
* AGG-SWITCH#2.7 # configure eaps e3-domain mode master
* AGG-SWITCH#2.8 # configure eaps e4-domain mode master
* AGG-SWITCH#2.9 # configure eaps e1-domain primary port 2:1
* AGG-SWITCH#2.10 # configure eaps e1-domain secondary port 1:1
* AGG-SWITCH#2.11 # configure eaps e2-domain primary port 2:1
* AGG-SWITCH#2.12 # configure eaps e2-domain secondary port 1:4
* AGG-SWITCH#2.13 # configure eaps e3-domain primary port 2:1
* AGG-SWITCH#2.14 # configure eaps e3-domain secondary port 3:1
* AGG-SWITCH#2.15 # configure eaps e4-domain primary port 2:1
* AGG-SWITCH#2.16 # configure eaps e4-domain secondary port 3:2
```

EAPS transit node configuration:

```
* AGG-SWITCH#1.1 # create eaps e1-domain
* AGG-SWITCH#1.2 # create eaps e2-domain
* AGG-SWITCH#1.3 # create eaps e3-domain
* AGG-SWITCH#1.4 # create eaps e4-domain
* AGG-SWITCH#1.5 # configure eaps e1-domain mode transit
* AGG-SWITCH#1.6 # configure eaps e2-domain mode transit
* AGG-SWITCH#1.7 # configure eaps e3-domain mode transit
* AGG-SWITCH#1.8 # configure eaps e4-domain mode transit
* AGG-SWITCH#1.9 # configure eaps e1-domain primary port 2:1
* AGG-SWITCH#1.10 # configure eaps e1-domain secondary port 1:1
* AGG-SWITCH#1.11 # configure eaps e2-domain primary port 2:1
* AGG-SWITCH#1.12 # configure eaps e2-domain secondary port 1:4
* AGG-SWITCH#1.13 # configure eaps e3-domain primary port 2:1
* AGG-SWITCH#1.14 # configure eaps e3-domain secondary port 3:1
* AGG-SWITCH#1.15 # configure eaps e4-domain primary port 2:1
* AGG-SWITCH#1.16 # configure eaps e4-domain secondary port 3:2
```

Creating and Configuring the EAPS Control VLANs. Create the EAPS control VLANs (one for each domain) and configure the 802.1q tag, and ring ports for each. Next, configure the control VLANs as part of their respective EAPS domain. The control VLAN only contains the EAPS primary and secondary ports configured earlier. The following commands are entered on both aggregate switches:

```
* AGG-SWITCH.17 # create vlan control-1
* AGG-SWITCH.18 # create vlan control-2
* AGG-SWITCH.19 # create vlan control-3
* AGG-SWITCH.20 # create vlan control-4
* AGG-SWITCH.21 # configure vlan control-1 tag 4001
* AGG-SWITCH.22 # configure vlan control-2 tag 4002
* AGG-SWITCH.23 # configure vlan control-3 tag 4003
* AGG-SWITCH.24 # configure vlan control-4 tag 4004
* AGG-SWITCH.29 # configure vlan control-1 add port 2:1,1:1 tagged
* AGG-SWITCH.30 # configure vlan control-2 add port 2:1,1:4 tagged
* AGG-SWITCH.31 # configure vlan control-3 add port 2:1,3:1 tagged
* AGG-SWITCH.32 # configure vlan control-4 add port 2:1,3:2 tagged
* AGG-SWITCH.33 # configure eaps e1-domain add control vlan control-1
* AGG-SWITCH.34 # configure eaps e2-domain add control vlan control-2
* AGG-SWITCH.35 # configure eaps e3-domain add control vlan control-3
* AGG-SWITCH.36 # configure eaps e4-domain add control vlan control-4
```

Creating and Configuring the EAPS Shared Ports. Create the EAPS shared ports, which are used to connect a common-link between the aggregate switches. On the first switch, define the shared port mode as *partner*, and define the link ID. Repeat this step on the other aggregate switch, but configure the shared port mode as *controller*. The link ID matches the value configured for the partner. The following shows an example configuration for the partner:

```
* AGG-SWITCH#2.37 # create eaps shared-port 2:1
* AGG-SWITCH#2.38 # configure eaps shared-port 2:1 mode partner
* AGG-SWITCH#2.39 # configure eaps shared-port 2:1 link-id 21
```

Enabling the EAPS Protocol and EAPS Domain. Enable the EAPS protocol on the switch, and enable EAPS to run on each domain created. The following commands are entered on both aggregate switches.

```
* AGG-SWITCH.40 # enable eaps
* AGG-SWITCH.41 # enable eaps e1-domain
* AGG-SWITCH.42 # enable eaps e2-domain
* AGG-SWITCH.43 # enable eaps e3-domain
* AGG-SWITCH.44 # enable eaps e4-domain
```

Creating and Configuring the EAPS Protected VLANs. Create the EAPS protected VLANs for each domain. Then configure an 802.1q tag and the ports for each protected VLAN. After that, configure each protected VLAN as part of the EAPS domain. Depending on the scope of the VLAN, it could be added to multiple EAPS domains. This type of VLAN is referred to as an overlapping protected VLAN, and requires shared port configurations. In this example, there is one overlapping protected VLAN *purple-1*, while all other VLANs are isolated to a single EAPS domain (VLANs *green-1*, *orange-1*, and *red-1*). Protected VLAN configuration, such as 802.1q tagging, must match on the edge switch. The commands in the following example are entered on both aggregate switches. This procedure can also be repeated for additional protected VLANs as needed:

```
* AGG-SWITCH.44 # create vlan purple-1
* AGG-SWITCH.45 # create vlan green-1
* AGG-SWITCH.46 # create vlan orange-1
* AGG-SWITCH.47 # create vlan red-1
* AGG-SWITCH.48 # configure purple-1 tag 1
```

```

* AGG-SWITCH.49 # configure green-1 tag 2
* AGG-SWITCH.50 # configure orange-1 tag 3
* AGG-SWITCH.51 # configure red-1 tag 4
* AGG-SWITCH.52 # configure eaps e1-domain add protect vlan purple-1
* AGG-SWITCH.53 # configure eaps e2-domain add protect vlan purple-1
* AGG-SWITCH.54 # configure eaps e3-domain add protect vlan purple-1
* AGG-SWITCH.55 # configure eaps e4-domain add protect vlan purple-1
* AGG-SWITCH.56 # configure eaps e2-domain add protect vlan green-1
* AGG-SWITCH.57 # configure eaps e3-domain add protect vlan orange-1
* AGG-SWITCH.58 # configure eaps e4-domain add protect vlan red-1
* AGG-SWITCH.59 # configure vlan purple-1 add port 2:1,1:1,1:4,3:1,3:2 tagged
* AGG-SWITCH.60 # configure vlan green-1 add port 2:1,1:4 tagged
* AGG-SWITCH.61 # configure vlan orange-1 add port 2:1,3:1 tagged
* AGG-SWITCH.62 # configure vlan red-1 add port 2:1,3:2 tagged

```

Verifying the EAPS Configuration and Operating State. When the configuration is complete, confirm that the EAPS domain and shared port configuration is correct. Verify whether the EAPS state is *Complete* and the shared port status is *Ready*. Both ring ports must be plugged in to see the *Links-Up* state. This verification is performed on both aggregate switches.

EAPS master and partner node status verification example:

```

* AGG-SWITCH#2.63 # show eaps
EAPS Enabled: Yes
EAPS Fast-Convergence: Off
EAPS Display Config Warnings: On
EAPS Multicast Add Ring Ports: Off
EAPS Multicast Send IGMP Query: On
EAPS Multicast Temporary Flooding: Off
EAPS Multicast Temporary Flooding Duration: 15 sec
Number of EAPS instances: 4
# EAPS domain configuration :

```

```

-----
Domain State Mo En Pri Sec Control-Vlan VID Count
-----

```

```

e1-domain Complete M Y 2:1 1:1 control-1 (4001) 1
e2-domain Complete M Y 2:1 1:4 control-2 (4002) 2
e3-domain Complete M Y 2:1 3:1 control-3 (4003) 2
e4-domain Complete M Y 2:1 3:2 control-4 (4004) 2
-----

```

```

* AGG-SWITCH#2.64 # show eaps shared-port
EAPS shared-port count: 1
-----

```

```

Link Domain Vlan RB RB
Shared-port Mode Id Up State count count Nbr State Id
-----
2:1 Partner 21 Y Ready 4 4 Yes None None
-----

```

EAPS transit and controller node status verification example:

```
* AGG-SWITCH#1.63 # show eaps
EAPS Enabled: Yes
EAPS Fast-Convergence: Off
EAPS Display Config Warnings: On
EAPS Multicast Add Ring Ports: Off
EAPS Multicast Send IGMP Query: On
EAPS Multicast Temporary Flooding: Off
EAPS Multicast Temporary Flooding Duration: 15 sec
Number of EAPS instances: 4
# EAPS domain configuration :
```

```
-----
Domain State Mo En Pri Sec Control-Vlan VID Count
-----
```

```
e1-domain Links-Up M Y 2:1 1:1 control-1 (4001) 1
e2-domain Links-Up M Y 2:1 1:4 control-2 (4002) 2
e3-domain Links-Up M Y 2:1 3:1 control-3 (4003) 2
e4-domain Links-Up M Y 2:1 3:2 control-4 (4004) 2
-----
```

```
* AGG-SWITCH#1.64 # show eaps shared-port
EAPS shared-port count: 1
-----
```

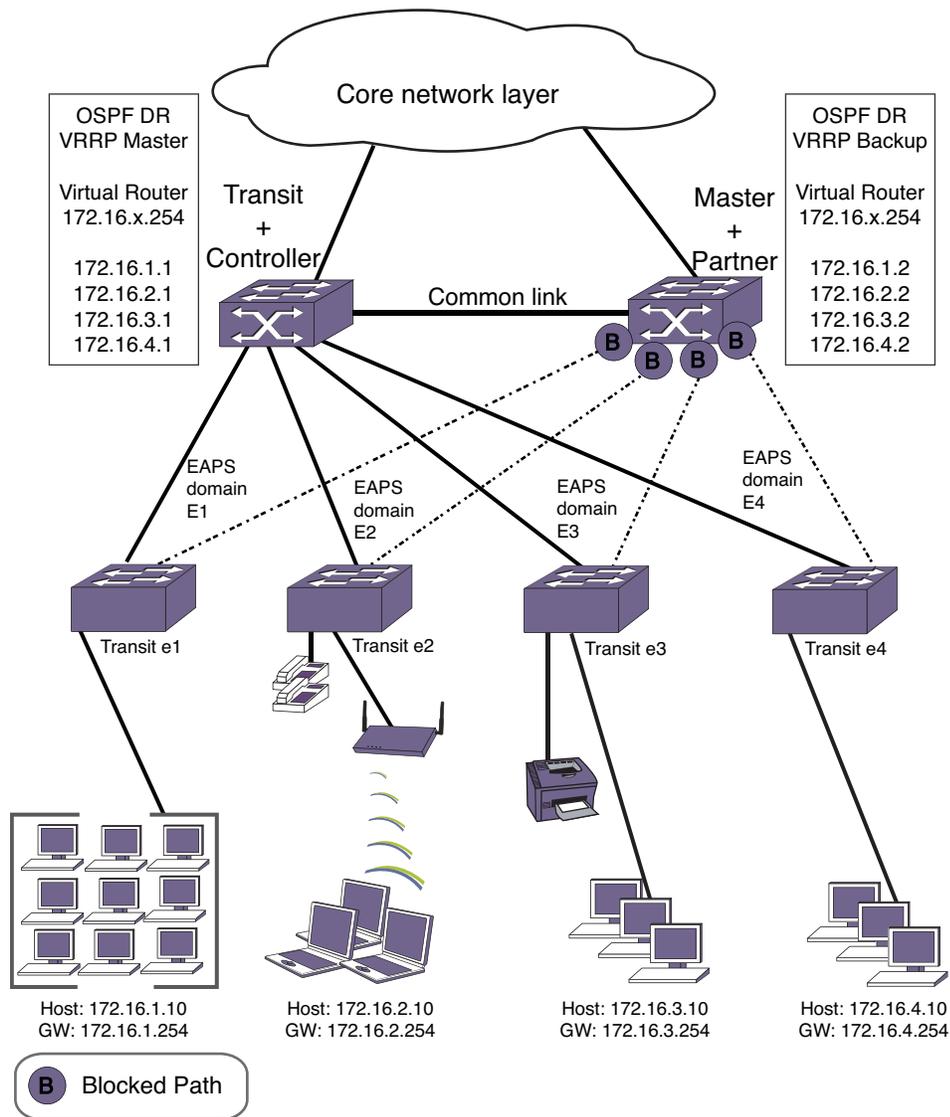
```
Link Domain Vlan RB RB
Shared-port Mode Id Up State count count Nbr State Id
-----
```

```
2:1 Controller 21 Y Ready 4 4 Yes None None
-----
```

Designing and Configuring L3 Services on Top of EAPS

This section explains how to run L3 routing services on top of EAPS as a foundation. In this example, OSPF is used as the dynamic IP routing protocol to communicate between different VLANs. To provide redundancy at the router level, VRRP is used to protect against an aggregation switch failure. VRRP allows one aggregation switch to route IP traffic, and if it fails the other aggregation switch takes over the IP routing role. Each EAPS protected VLAN provides L3 connectivity to the clients by configuring IP addressing, OSPF routing, and VRRP on the aggregation switches.

Figure 129: L2 and L3 Aggregation Network Layer



EX_eaps_0056

IP routing is added to the design on the access network switches by configuring each EAPS protected VLAN as an OSPF interface. Since these are broadcast OSPF interfaces, we need to specify a Designated Router (DR) and Backup Designated Router (BDR). While the EAPS transit and controller node is not blocking any ports, it is configured as the OSPF Designated Router (DR).

The EAPS master and partner node is then configured as the BDR. Similarly, the EAPS transit and controller node is also configured as the VRRP master, which provides L3 routing to the hosts. The EAPS master and partner node is configured as the VRRP backup router for redundancy.

Using redundant aggregation switches with VRRP protects against a single point of failure at the switch level. Client devices receive non-stop IP routing services in the event of link or aggregation switch failure without any reconfiguration. OSPF provides fast convergence from any routing failures. EAPS provides the resilient L2 foundation and minimizes the occurrence of routing interface flaps or dropped OSPF neighbor adjacencies.

To configure L3 on the aggregation switches, completed the tasks described in the following sections:

- 1 [Configuring IP Addresses on the EAPS Protected VLANs on page 976](#)
- 2 [Configuring OSPF on the EAPS Protected VLANs on page 976](#)
- 3 [Configuring VRRP on the EAPS Protected VLANs on page 977](#)
- 4 [Verifying OSPF and VRRP Configuration Status on page 977](#)

Configuring IP Addresses on the EAPS Protected VLANs. Configure IP addresses on the EAPS protected VLANs. Client host stations need the IP address configuration to match their protected VLANs. The edge switches do not require IP addresses, but this could optionally be done for management or troubleshooting purposes.

IP address configuration example:

```
* AGG-SWITCH#1.1 # configure vlan green-1 ipaddress 172.16.1.1/24
* AGG-SWITCH#1.2 # configure vlan purple-1 ipaddress 172.16.2.1/24
* AGG-SWITCH#1.3 # configure vlan orange-1 ipaddress 172.16.3.1/24
* AGG-SWITCH#1.4 # configure vlan red-1 ipaddress 172.16.4.1/24

* AGG-SWITCH#2.1 # configure vlan green-1 ipaddress 172.16.1.2/24
* AGG-SWITCH#2.2 # configure vlan purple-1 ipaddress 172.16.2.2/24
* AGG-SWITCH#2.3 # configure vlan orange-1 ipaddress 172.16.3.2/24
* AGG-SWITCH#2.4 # configure vlan red-1 ipaddress 172.16.4.2/24
```

Configuring OSPF on the EAPS Protected VLANs. Configure OSPF and enable routing on the EAPS protected VLANs for each aggregation switch. Since OSPF broadcast networks are being used, configure the DR and BDR for each VLAN. Configure the EAPS transit and controller as the DR by using a higher OSPF priority value since it is not performing L2 blocking. The EAPS master and partner switch is configured as the BDR. In this example, all edge EAPS protected VLANs are placed in the OSPF backbone area, but another OSPF area could be created if desired.

OSPF DR configuration:

```
* AGG-SWITCH#1.5 # enable ipforwarding vlan green-1
* AGG-SWITCH#1.6 # enable ipforwarding vlan purple-1
* AGG-SWITCH#1.7 # enable ipforwarding vlan orange-1
* AGG-SWITCH#1.8 # enable ipforwarding vlan red-1
* AGG-SWITCH#1.9 # configure ospf routerid 172.16.1.1
* AGG-SWITCH#1.10 # configure ospf add vlan green-1 area 0.0.0.0
* AGG-SWITCH#1.11 # configure ospf add vlan purple-1 area 0.0.0.0
* AGG-SWITCH#1.12 # configure ospf add vlan orange-1 area 0.0.0.0
* AGG-SWITCH#1.13 # configure ospf add vlan red-1 area 0.0.0.0
* AGG-SWITCH#1.14 # configure ospf vlan green-1 priority 110
* AGG-SWITCH#1.15 # configure ospf vlan purple-1 priority 110
* AGG-SWITCH#1.16 # configure ospf vlan orange-1 priority 110
* AGG-SWITCH#1.17 # configure ospf vlan red-1 priority 110
* AGG-SWITCH#1.18 # enable ospf
```

OSPF BDR Configuration

```
* AGG-SWITCH#2.5 # enable ipforwarding vlan green-1
* AGG-SWITCH#2.6 # enable ipforwarding vlan purple-1
* AGG-SWITCH#2.7 # enable ipforwarding vlan orange-1
* AGG-SWITCH#2.8 # enable ipforwarding vlan red-1
* AGG-SWITCH#2.9 # configure ospf routerid 172.16.1.2
* AGG-SWITCH#2.10 # configure ospf add vlan green-1 area 0.0.0.0
* AGG-SWITCH#2.11 # configure ospf add vlan purple-1 area 0.0.0.0
```

```
* AGG-SWITCH#2.12 # configure ospf add vlan orange-1 area 0.0.0.0
* AGG-SWITCH#2.13 # configure ospf add vlan red-1 area 0.0.0.0
* AGG-SWITCH#2.14 # configure ospf vlan green-1 priority 100
* AGG-SWITCH#2.15 # configure ospf vlan purple-1 priority 100
* AGG-SWITCH#2.16 # configure ospf vlan orange-1 priority 100
* AGG-SWITCH#2.17 # configure ospf vlan red-1 priority 100
* AGG-SWITCH#2.18 # enable ospf
```

Configuring VRRP on the EAPS Protected VLANs. Configure VRRP on each of the EAPS protected VLANs. The VRRP virtual router is configured with the virtual IP address of 172.16.x.254 for each VLAN (example VLAN *green-1* = 172.16.1.254). The VRRP virtual router IP address is configured as the default gateway of each client machine. Since it is not performing L2 blocking, configure the EAPS transit and controller as VRRP master router by using a higher priority value. The EAPS master and partner switch is configured as the VRRP backup router.

VRRP master router configuration:

```
* AGG-SWITCH#1.19 # create vrrp vlan green-1 vrid 1
* AGG-SWITCH#1.20 # configure vrrp vlan green-1 vrid 1 priority 110
* AGG-SWITCH#1.21 # configure vrrp vlan green-1 vrid 1 add 172.16.1.254
* AGG-SWITCH#1.22 # enable vrrp vlan green-1 vrid 1
* AGG-SWITCH#1.23 # create vrrp vlan purple-1 vrid 1
* AGG-SWITCH#1.24 # configure vrrp vlan purple-1 vrid 1 priority 110
* AGG-SWITCH#1.25 # configure vrrp vlan purple-1 vrid 1 add 172.16.2.254
* AGG-SWITCH#1.26 # enable vrrp vlan purple-1 vrid 1
* AGG-SWITCH#1.27 # create vrrp vlan orange-1 vrid 1
* AGG-SWITCH#1.28 # configure vrrp vlan orange-1 vrid 1 priority 110
* AGG-SWITCH#1.29 # configure vrrp vlan orange-1 vrid 1 add 172.16.3.254
* AGG-SWITCH#1.30 # enable vrrp vlan orange-1 vrid 1
* AGG-SWITCH#1.31 # create vrrp vlan red-1 vrid 1
* AGG-SWITCH#1.32 # configure vrrp vlan red-1 vrid 1 priority 110
* AGG-SWITCH#1.33 # configure vrrp vlan red-1 vrid 1 add 172.16.4.254
* AGG-SWITCH#1.34 # enable vrrp vlan red-1 vrid 1
```

VRRP backup router configuration:

```
* AGG-SWITCH#2.19 # create vrrp vlan green-1 vrid 1
* AGG-SWITCH#2.20 # configure vrrp vlan green-1 vrid 1 priority 100
* AGG-SWITCH#2.21 # configure vrrp vlan green-1 vrid 1 add 172.16.1.254
* AGG-SWITCH#2.22 # enable vrrp vlan green-1 vrid 1
* AGG-SWITCH#2.23 # create vrrp vlan purple-1 vrid 1
* AGG-SWITCH#2.24 # configure vrrp vlan purple-1 vrid 1 priority 100
* AGG-SWITCH#2.25 # configure vrrp vlan purple-1 vrid 1 add 172.16.2.254
* AGG-SWITCH#2.26 # enable vrrp vlan purple-1 vrid 1
* AGG-SWITCH#2.27 # create vrrp vlan orange-1 vrid 1
* AGG-SWITCH#2.28 # configure vrrp vlan orange-1 vrid 1 priority 100
* AGG-SWITCH#2.29 # configure vrrp vlan orange-1 vrid 1 add 172.16.3.254
* AGG-SWITCH#2.30 # enable vrrp vlan orange-1 vrid 1
* AGG-SWITCH#2.31 # create vrrp vlan red-1 vrid 1
* AGG-SWITCH#2.32 # configure vrrp vlan red-1 vrid 1 priority 100
* AGG-SWITCH#2.33 # configure vrrp vlan red-1 vrid 1 add 172.16.4.254
* AGG-SWITCH#2.34 # enable vrrp vlan red-1 vrid 1
```

Verifying OSPF and VRRP Configuration Status. Verify the OSPF neighbor adjacencies are established and that the DR and BDR status is correct. Verify that the VRRP virtual router is running and the VRRP master/backup status is correct.

OSPF and VRRP verification example:

```

* AGG-SWITCH#1.35 # show ospf neighbor
Neighbor ID Pri State Up/Dead Time Address Interface
172.16.1.2 100 FULL /BDR 00:18:01:08/00:00:00:03 172.16.3.2 orange-1
172.16.1.2 100 FULL /BDR 00:18:01:08/00:00:00:03 172.16.4.2 red-1
172.16.1.2 100 FULL /BDR 00:17:54:17/00:00:00:03 172.16.1.2 green-1
172.16.1.2 100 FULL /BDR 00:17:54:07/00:00:00:03 172.16.2.2 purple-1
* AGG-SWITCH#1.36 # show vrrp
VLAN Name VRID Pri Virtual IP Addr State Master Mac Address TP/TR/TV/P/T
green-1(En) 0001 110 172.16.1.254 MSTR 00:00:5e:00:01:01 0 0 0 Y 1
purple-(En) 0001 110 172.16.2.254 MSTR 00:00:5e:00:01:01 0 0 0 Y 1
orange-(En) 0001 110 172.16.3.254 MSTR 00:00:5e:00:01:01 0 0 0 Y 1
red-1(En) 0001 110 172.16.4.254 MSTR 00:00:5e:00:01:01 0 0 0 Y 1
En-Enabled, Ds-Disabled, Pri-Priority, T-Advert Timer, P-Preempt
TP-Tracked Pings, TR-Tracked Routes, TV-Tracked VLANs

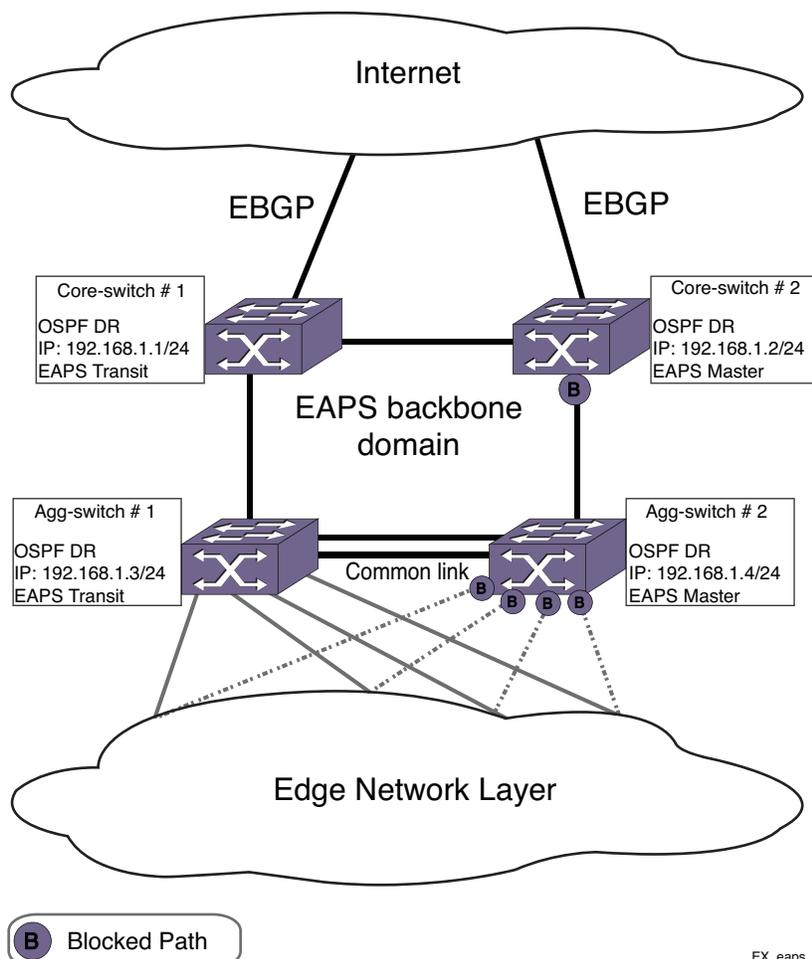
* AGG-SWITCH#2.35 # show ospf neighbor
Neighbor ID Pri State Up/Dead Time Address Interface
172.16.1.1 110 FULL /DR 00:18:01:08/00:00:00:03 172.16.3.1 orange-1
172.16.1.1 110 FULL /DR 00:18:01:08/00:00:00:03 172.16.4.1 red-1
172.16.1.1 110 FULL /DR 00:17:54:17/00:00:00:03 172.16.1.1 green-1
172.16.1.1 110 FULL /DR 00:17:54:07/00:00:00:03 172.16.2.1 purple-1
* AGG-SWITCH#2.36 # show vrrp
VLAN Name VRID Pri Virtual IP Addr State Master Mac Address TP/TR/TV/P/T
green-1(En) 0001 100 172.16.1.254 BKUP 00:00:5e:00:01:01 0 0 0 Y 1
purple-(En) 0001 100 172.16.2.254 BKUP 00:00:5e:00:01:01 0 0 0 Y 1
orange-(En) 0001 100 172.16.3.254 BKUP 00:00:5e:00:01:01 0 0 0 Y 1
red-1(En) 0001 100 172.16.4.254 BKUP 00:00:5e:00:01:01 0 0 0 Y 1
En-Enabled, Ds-Disabled, Pri-Priority, T-Advert Timer, P-Preempt
TP-Tracked Pings, TR-Tracked Routes, TV-Tracked VLANs

```

Designing and Configuring the Core Layer with EAPS

The core switches provide high performance backbone routing between the edge, aggregation, datacenter, and external Internet networks. An additional high availability backbone ring is built which combines EAPS and OSPF. Using EAPS and OSPF together increases the stability of IP routing tables. Since EAPS provides 50-millisecond convergence for link failures, OSPF adjacencies do not flap. In this example, the backbone ring is formed by adding two core L2/L3 switches and connecting them to the two existing aggregation switches. The core switches also provide routing to the Internet using BGP (see [Figure 130](#)).

Figure 130: Core EAPS and OSPF Network Layer



Using redundant core switches protects against a single point of failure at the switch level. OSPF provides fast convergence from any routing failures. EAPS provides the resilient L2 foundation and minimizes the occurrence of routing interface flaps or dropped OSPF neighbor adjacencies. Combining EAPS and OSPF provides the highest level of network resiliency and routing stability.

Configuring the core switches requires a new EAPS domain with a single EAPS protected VLAN with OSPF forming the backbone IP network. Additional configuration is needed on the aggregation switches to connect them to the backbone EAPS and OSPF ring. Since the steps are similar to previous configuration examples, the L2 (EAPS) and L3 (OSPF) configurations are combined. Since the BGP configuration is independent of EAPS configuration, BGP configuration is not discussed here.

To configure backbone connectivity on the core and aggregation switches, complete the tasks described in the following sections:

- 1 [Creating and Configuring the Backbone EAPS Domain on page 980](#)
- 2 [Creating and Configuring the Backbone EAPS Control VLAN on page 980](#)
- 3 [Creating and Configuring the Backbone EAPS Protected VLANs on page 981](#)
- 4 [Configuring an IP Address and OSPF on the Backbone VLAN on page 981](#)
- 5 [Verifying EAPS and OSPF Configuration Status on page 982](#)

Creating and Configuring the Backbone EAPS Domain. Create the backbone EAPS domains and configure the EAPS mode. Define the primary and secondary ports for each domain. Configure on both core and aggregation switches.

Core-Switch 1 EAPS configuration:

```
* CORE-SWITCH#1.1 # create eaps e5-domain
* CORE-SWITCH#1.2 # configure eaps e5-domain mode transit
* CORE-SWITCH#1.3 # configure eaps e5-domain primary port 2:1
* CORE-SWITCH#1.4 # configure eaps e5-domain secondary port 2:4
```

Core-Switch 2 EAPS configuration:

```
* CORE-SWITCH#2.1 # create eaps e5-domain
* CORE-SWITCH#2.2 # configure eaps e5-domain mode master
* CORE-SWITCH#2.3 # configure eaps e5-domain primary port 2:1
* CORE-SWITCH#2.4 # configure eaps e5-domain secondary port 2:4
```

Agg-Switch 1 EAPS configuration:

```
* AGG-SWITCH#1.1 # create eaps e5-domain
* AGG-SWITCH#1.2 # configure eaps e5-domain mode transit
* AGG-SWITCH#1.3 # configure eaps e5-domain primary port 2:1
* AGG-SWITCH#1.4 # configure eaps e5-domain secondary port 2:4
```

Agg-Switch 2 EAPS configuration:

```
* AGG-SWITCH#2.1 # create eaps e5-domain
* AGG-SWITCH#2.2 # configure eaps e5-domain mode transit
* AGG-SWITCH#2.3 # configure eaps e5-domain primary port 2:1
* AGG-SWITCH#2.4 # configure eaps e5-domain secondary port 2:4
```

Creating and Configuring the Backbone EAPS Control VLAN. Create the EAPS control VLAN and configure its 802.1q tag, and ring ports. Next, configure the control VLANs as part of the backbone EAPS domain. Enable EAPS and the backbone EAPS domain. Configure on both core and aggregation switches (EAPS is already enabled on aggregation switches).

Core-Switch#1 control VLAN configuration:

```
* CORE-SWITCH#1.1 # create vlan control-5
* CORE-SWITCH#1.2 # configure vlan control-5 tag 4005
* CORE-SWITCH#1.4 # configure vlan control-5 add port 2:1,2:4 tagged
* CORE-SWITCH#1.5 # configure eaps e5-domain add control vlan control-5
* CORE-SWITCH#1.6 # enable eaps
* CORE-SWITCH#1.7 # enable eaps e5-domain
```

Core-Switch#2 control VLAN configuration:

```
* CORE-SWITCH#2.1 # create vlan control-5
* CORE-SWITCH#2.2 # configure vlan control-5 tag 4005
* CORE-SWITCH#2.4 # configure vlan control-5 add port 2:1,2:4 tagged
* CORE-SWITCH#2.5 # configure eaps e5-domain add control vlan control-5
* CORE-SWITCH#2.6 # enable eaps
* CORE-SWITCH#2.7 # enable eaps e5-domain
```

Agg-Switch#1 control VLAN configuration:

```
* AGG-SWITCH#1.1 # create vlan control-5
* AGG-SWITCH#1.2 # configure vlan control-5 tag 4005
* AGG-SWITCH#1.4 # configure vlan control-5 add port 2:4,2:6 tagged
* AGG-SWITCH#1.5 # configure eaps e5-domain add control vlan control-5
* AGG-SWITCH#1.6 # enable eaps e5-domain
```

Agg-Switch#2 control VLAN configuration:

```
* AGG-SWITCH#2.1 # create vlan control-5
* AGG-SWITCH#2.2 # configure vlan control-5 tag 4005
* AGG-SWITCH#2.4 # configure vlan control-5 add port 2:4,2:6 tagged
* AGG-SWITCH#2.5 # configure eaps e5-domain add control vlan control-5
* AGG-SWITCH#1.6 # enable eaps e5-domain
```

Creating and Configuring the Backbone EAPS Protected VLANs. Create the EAPS protected VLAN for the backbone domain. Then configure the 802.1q tag and ports for the protected VLANs. Since this VLAN is only used for transit routing, there are no other ports besides the ring ports. Next, configure the protected VLAN as part of the EAPS domain. Do this configuration on both the core and aggregate switches.

Core-Switch#1 protected VLAN configuration:

```
* CORE-SWITCH#1.8 # create vlan backbone
* CORE-SWITCH#1.9 # configure vlan backbone tag 3000
* CORE-SWITCH#1.10 # configure vlan backbone add port 2:1,2:4 tagged
* CORE-SWITCH#1.11 # configure eaps e5-domain add protect vlan backbone
```

Core-Switch#2 protected VLAN configuration:

```
* CORE-SWITCH#2.8 # create vlan backbone
* CORE-SWITCH#2.9 # configure vlan backbone tag 3000
* CORE-SWITCH#2.10 # configure vlan backbone add port 2:1,2:4 tagged
* CORE-SWITCH#2.11 # configure eaps e5-domain add protect vlan backbone
```

Agg-Switch#1 protected VLAN configuration:

```
* AGG-SWITCH#1.7 # create vlan backbone
* AGG-SWITCH#1.8 # configure vlan backbone tag 3000
* AGG-SWITCH#1.9 # configure vlan backbone add port 2:4,2:6 tagged
* AGG-SWITCH#1.10 # configure eaps e5-domain add protect vlan backbone
```

Agg-Switch#2 protected VLAN configuration:

```
* AGG-SWITCH#2.7 # create vlan backbone
* AGG-SWITCH#2.8 # configure vlan backbone tag 3000
* AGG-SWITCH#2.9 # configure vlan backbone add port 2:4,2:6 tagged
* AGG-SWITCH#2.10 # configure eaps e5-domain add protect vlan backbone
```

Configuring an IP Address and OSPF on the Backbone VLAN. Configure an IP address and enable IP forwarding (routing) on the *backbone* protected VLAN. Next, OSPF is configured and since an OSPF broadcast network is used, configure the designated router and backup designated router for each VLAN. Since it is not performing L2 blocking, configure the EAPS transit core switch as the DR by using a higher OSPF priority value. The EAPS master core switch is configured as the BDR. The aggregation transit switches need not perform DR/BDR duties for the *backbone* VLAN, so their OSPF priority is configured at 0 to force ODR behavior.

Core-Switch#1 OSPF configuration:

```
* CORE-SWITCH#1.12 # configure vlan backbone ipaddress 192.168.1.1/24
* CORE-SWITCH#1.13 # enable ipforwarding vlan backbone
* CORE-SWITCH#1.14 # configure ospf routerid 192.168.1.1
* CORE-SWITCH#1.15 # configure ospf add vlan backbone area 0.0.0.0
* CORE-SWITCH#1.16 # configure ospf vlan backbone priority 110
* CORE-SWITCH#1.17 # enable ospf
```

Core-Switch#2 OSPF configuration:

```
* CORE-SWITCH#2.12 # configure vlan backbone ipaddress 192.168.1.2/24
* CORE-SWITCH#2.13 # enable ipforwarding vlan backbone
* CORE-SWITCH#2.14 # configure ospf routerid 192.168.1.2
* CORE-SWITCH#2.15 # configure ospf add vlan backbone area 0.0.0.0
* CORE-SWITCH#2.16 # configure ospf vlan backbone priority 100
* CORE-SWITCH#2.17 # enable ospf
```

Agg-Switch#1 OSPF configuration:

```
* AGG-SWITCH#1.11 # configure vlan backbone ipaddress 192.168.1.3/24
* AGG-SWITCH#1.12 # enable ipforwarding vlan backbone
* AGG-SWITCH#1.13 # configure ospf add vlan backbone area 0.0.0.0
* AGG-SWITCH#1.14 # configure ospf vlan backbone priority 0
```

Agg-Switch#2 OSPF configuration:

```
* AGG-SWITCH#2.11 # configure vlan backbone ipaddress 192.168.1.4/24
* AGG-SWITCH#2.12 # enable ipforwarding vlan backbone
* AGG-SWITCH#2.13 # configure ospf add vlan backbone area 0.0.0.0
* AGG-SWITCH#2.14 # configure ospf vlan backbone priority 0
```

Verifying EAPS and OSPF Configuration Status. Verify that the backbone EAPS domain and OSPF configuration is correct. Confirm that the OSPF neighbor adjacencies and DR/BDR/ODR status are correct. Verify this status on both aggregate switches.

Core-Switch#1 EAPS and OSPF status example:

```
* CORE-SWITCH#1.18 # show eaps
EAPS Enabled: Yes
EAPS Fast-Convergence: On
EAPS Display Config Warnings: On
EAPS Multicast Add Ring Ports: Off
EAPS Multicast Send IGMP Query: On
EAPS Multicast Temporary Flooding: Off
EAPS Multicast Temporary Flooding Duration: 15 sec
Number of EAPS instances: 1
# EAPS domain configuration :
-----
Domain State Mo En Pri Sec Control-Vlan VID Count
-----
e5-domain Links-Up T Y 2:1 2:4 control-5 (4005) 1
-----
* CORE-SWITCH#1.19 # show ospf neighbor
Neighbor ID Pri State Up/Dead Time Address Interface
192.168.1.3 0 2WAY /DROTHER00:05:23:17/00:00:00:07 192.168.1.3 backbone
192.168.1.4 0 2WAY /DROTHER00:05:23:17/00:00:00:07 192.168.1.4 backbone 192.168.1.2
100 FULL /BDR 00:05:23:17/00:00:00:09 192.168.1.2 backbone
```

Core-Switch#2 EAPS and OSPF status example:

```
* CORE-SWITCH#2.18 # show eaps
EAPS Enabled: Yes
EAPS Fast-Convergence: On
EAPS Display Config Warnings: On
EAPS Multicast Add Ring Ports: Off
EAPS Multicast Send IGMP Query: On
EAPS Multicast Temporary Flooding: Off
EAPS Multicast Temporary Flooding Duration: 15 sec
Number of EAPS instances: 1
# EAPS domain configuration :
-----
Domain State Mo En Pri Sec Control-Vlan VID Count
-----
e5-domain Complete T Y 2:1 2:4 control-5 (4005) 1
-----
* CORE-SWITCH#2.19 # show ospf neighbor
Neighbor ID Pri State Up/Dead Time Address Interface
192.168.1.3 0 2WAY /DROTHER00:05:23:17/00:00:00:07 192.168.1.3 backbone
192.168.1.4 0 2WAY /DROTHER00:05:23:17/00:00:00:07 192.168.1.4 backbone 192.168.1.1
110 FULL /DR 00:05:23:17/00:00:00:09 192.168.1.1 backbone
```

Agg-Switch#1 EAPS and OSPF status example:

```
* AGG-SWITCH#1.15 # show eaps
EAPS Enabled: Yes
EAPS Fast-Convergence: On
EAPS Display Config Warnings: On
EAPS Multicast Add Ring Ports: Off
EAPS Multicast Send IGMP Query: On
EAPS Multicast Temporary Flooding: Off
EAPS Multicast Temporary Flooding Duration: 15 sec
Number of EAPS instances: 5
# EAPS domain configuration :
-----
Domain State Mo En Pri Sec Control-Vlan VID Count
-----
e1-domain Links-Up T Y 1:1 2:1 control-1 (4001) 2
e2-domain Links-Up T Y 1:4 2:1 control-2 (4002) 2
e3-domain Links-Up T Y 3:1 2:1 control-3 (4003) 2
e4-domain Links-Up T Y 3:2 2:1 control-4 (4004) 2
e5-domain Links-Up T Y 2:4 2:6 control-5 (4005) 1
-----
* AGG-SWITCH#1.16 # show ospf neighbor
Neighbor ID Pri State Up/Dead Time Address Interface
192.168.1.1 110 FULL /DR 00:00:28:51/00:00:00:01 192.168.1.1 backbone 192.168.1.2 100
FULL /BDR 00:00:28:51/00:00:00:01 192.168.1.2 backbone
192.168.1.4 0 2WAY /DROTHER00:05:45:40/00:00:00:03 192.168.1.4 backbone
172.16.1.2 100 FULL /BDR 00:18:01:08/00:00:00:03 172.16.3.2 orange-1
172.16.1.2 100 FULL /BDR 00:18:01:08/00:00:00:03 172.16.4.2 red-1
172.16.1.2 100 FULL /BDR 00:17:54:17/00:00:00:03 172.16.1.2 green-1
172.16.1.2 100 FULL /BDR 00:17:54:07/00:00:00:03 172.16.2.2 purple-1
```

Agg-Switch#2 EAPS and OSPF status example:

```
* AGG-SWITCH#2.15 # show eaps
EAPS Enabled: Yes
EAPS Fast-Convergence: On
EAPS Display Config Warnings: On
EAPS Multicast Add Ring Ports: Off
EAPS Multicast Send IGMP Query: On
EAPS Multicast Temporary Flooding: Off
EAPS Multicast Temporary Flooding Duration: 15 sec
Number of EAPS instances: 5
# EAPS domain configuration :
```

```
-----
Domain State Mo En Pri Sec Control-Vlan VID Count
-----
```

```
e1-domain Complete M Y 2:1 1:1 control-1 (4001) 2
e2-domain Complete M Y 2:1 1:4 control-2 (4002) 2
e3-domain Complete M Y 2:1 3:1 control-3 (4003) 2
e4-domain Complete M Y 2:1 3:2 control-4 (4004) 2
e5-domain Links-Up T Y 2:4 2:6 control-5 (4005) 1
-----
```

```
* AGG-SWITCH#2.16 # show ospf neighbor
```

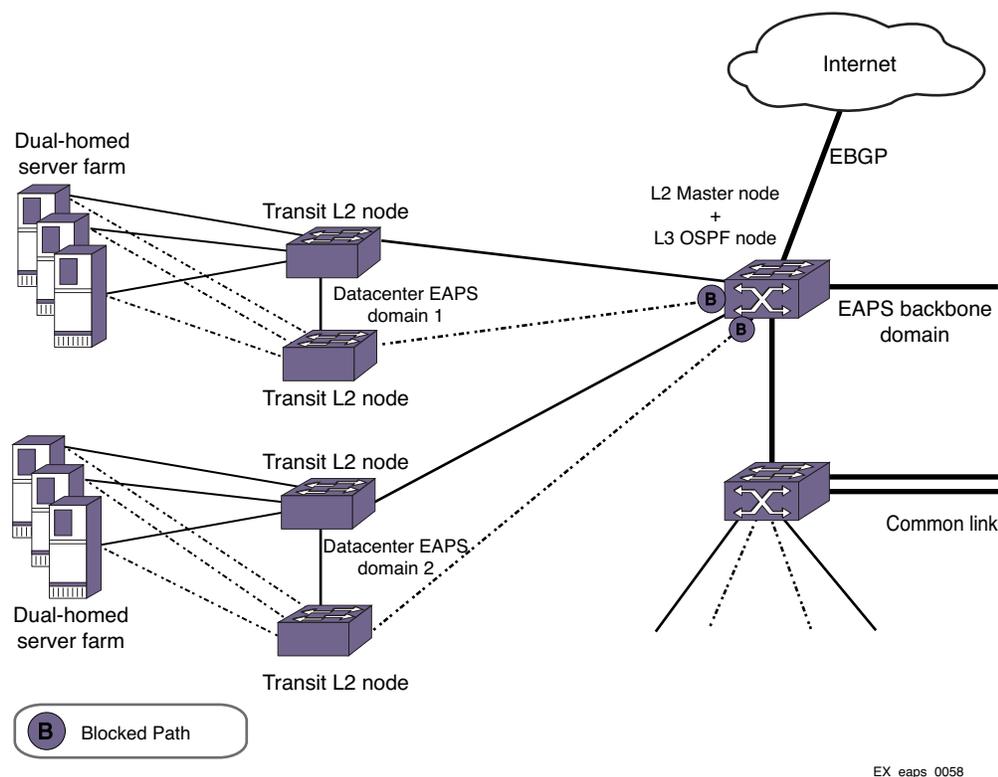
```
Interface
192.168.1.1 110 FULL /DR 00:00:28:51/00:00:00:01 192.168.1.1 backbone
192.168.1.2 100 FULL /BDR 00:00:28:51/00:00:00:01 192.168.1.2 backbone
192.168.1.3 0 2WAY /DROTHER00:05:45:40/00:00:00:03 192.168.1.3 backbone
172.16.1.1 110 FULL /DR 00:18:01:08/00:00:00:03 172.16.3.1 orange-1
172.16.1.1 110 FULL /DR 00:18:01:08/00:00:00:03 172.16.4.1 red-1
172.16.1.1 110 FULL /DR 00:17:54:17/00:00:00:03 172.16.1.1 green-1
172.16.1.1 110 FULL /DR 00:17:54:07/00:00:00:03 172.16.2.1 purple-1
```

Designing and Configuring the Datacenter Switches with EAPS

Building from the network core, you can expand the network with additional EAPS rings to provide resiliency to mission-critical server farms. The core switches provide high performance backbone routing between the datacenter and the rest of the network, which includes both internal and external (Internet) destinations. The core switch acts as the EAPS master node for each ring, while the datacenter switches act as EAPS transit nodes to complete the ring. The core switch also acts as the OSPF routing node to provide gateway routing functionality to the server-farms. For an additional level of resiliency, each server is dual-homed (dual attached) to both EAPS transit L2 switches. Even if a switch or link fails, the servers are available. The network design and configuration is similar to the edge and aggregation EAPS and OSPF layers. The modular approach is simple and scalable, and allows additional datacenter rings to be added to provide room for growth. In our example, server-farms are isolated into separate categories such as external and internal service groups, which yield additional security and resiliency benefits.

To configure the datacenter switches you need a new EAPS domain with a single EAPS protected VLAN to form the server-farm network. In this example, two datacenter switches are configured as EAPS transit nodes (L2 switch only) and attach to the existing core switch acting as the EAPS master. Each server in the server-farm is dual-homed to both EAPS transit switches in the datacenter for additional physical resiliency. IP routing functionality is performed by the core switch via OSPF, which provides L3 connectivity to the rest of the network.

Figure 131: Datacenter EAPS and OSPF Network Layer



To configure datacenter connectivity, complete the tasks described in the following sections:

- 1 [Creating and Configuring the Datacenter EAPS Domain on page 985](#)
- 2 [Creating and Configuring the Datacenter EAPS Control VLAN on page 986](#)
- 3 [Creating and Configuring the Datacenter EAPS Protected VLANs on page 986](#)
- 4 [Configuring an IP Address and OSPF on the Backbone VLAN on page 987](#)
- 5 [Verifying EAPS and OSPF Configuration Status on page 987](#)

Creating and Configuring the Datacenter EAPS Domain. Create the backbone EAPS domains, configure the EAPS mode, and define the primary and secondary ports for each domain. You need to do this configuration on both core and aggregation switches.

Core-Switch#1 EAPS configuration:

```
* CORE-SWITCH#1.1 # create eaps e6-domain
* CORE-SWITCH#1.2 # configure eaps e6-domain mode master
* CORE-SWITCH#1.3 # configure eaps e6-domain primary port 4:1
* CORE-SWITCH#1.4 # configure eaps e6-domain secondary port 4:2
```

Datacenter-Switch#1 EAPS configuration:

```
* DC-SWITCH#1.1 # create eaps e6-domain
* DC-SWITCH#1.2 # configure eaps e6-domain mode transit
* DC-SWITCH#1.3 # configure eaps e6-domain primary port 49
* DC-SWITCH#1.4 # configure eaps e6-domain secondary port 50
```

Datacenter -Switch#2 EAPS configuration:

```
* DC-SWITCH#2.1 # create eaps e6-domain
* DC-SWITCH#2.2 # configure eaps e6-domain mode transit
* DC-SWITCH#2.3 # configure eaps e6-domain primary port 49
* DC-SWITCH#2.4 # configure eaps e6-domain secondary port 50
```

Creating and Configuring the Datacenter EAPS Control VLAN. Create the EAPS control VLAN and configure its 802.1q tag, and ring ports. Next, configure the control VLANs as part of the *Datacenter* EAPS domain. Enable EAPS and the datacenter EAPS domain. You need to do this configuration on the core and datacenter L2 switches.

Core-Switch#1 control VLAN configuration:

```
* CORE-SWITCH#1.1 # create vlan control-6
* CORE-SWITCH#1.2 # configure vlan control-6 tag 4006
* CORE-SWITCH#1.4 # configure vlan control-6 add port 4:1,4:2 tagged
* CORE-SWITCH#1.5 # configure eaps e5-domain add control vlan control-6
* CORE-SWITCH#1.6 # enable eaps e6-domain
```

Datacenter-Switch#1 control VLAN configuration:

```
* DC-SWITCH#1.1 # create vlan control-6
* DC-SWITCH#1.2 # configure vlan control-6 tag 4006
* DC-SWITCH#1.4 # configure vlan control-6 add port 49,50 tagged
* DC-SWITCH#1.5 # configure eaps e6-domain add control vlan control-6
* DC-SWITCH#1.6 # enable eaps
* DC-SWITCH#1.7 # enable eaps e6-domain
```

Datacenter-Switch#2 control VLAN configuration:

```
* DC-SWITCH#2.1 # create vlan control-6
* DC-SWITCH#2.2 # configure vlan control-6 tag 4006
* DC-SWITCH#2.4 # configure vlan control-6 add port 49,50 tagged
* DC-SWITCH#2.5 # configure eaps e6-domain add control vlan control-6
* DC-SWITCH#2.6 # enable eaps
* DC-SWITCH#2.7 # enable eaps e6-domain
```

Creating and Configuring the Datacenter EAPS Protected VLANs. Create the EAPS protected VLAN for the datacenter domain. Then configure the 802.1q tag and ports for the protected VLANs. Since each server is dual-homed to each datacenter switch, add a VLAN port on each switch for each server. Next, configure the protected VLAN as part of the EAPS domain. You need to do this configuration on the core and datacenter switches.

Core-Switch#1 protected VLAN configuration:

```
* CORE-SWITCH#1.7 # create vlan srvfarm-1
* CORE-SWITCH#1.8 # configure vlan srvfarm-1 tag 1000
* CORE-SWITCH#1.9 # configure vlan srvfarm-1 add port 4:1,4:2 tagged
* CORE-SWITCH#1.10 # configure eaps e6-domain add protect vlan srvfarm-1
```

Datacenter-Switch#1 protected VLAN configuration:

```
* DC-SWITCH#1.8 # create vlan srvfarm-1
* DC-SWITCH#1.9 # configure vlan srvfarm-1 tag 1000
* DC-SWITCH#1.10 # configure vlan srvfarm-1 add port 49,50 tagged
* DC-SWITCH#1.11 # configure vlan srvfarm-1 add port 1 untagged
* DC-SWITCH#1.12 # configure eaps e5-domain add protect vlan srvfarm-1
```

Datacenter-Switch#2 protected VLAN configuration:

```
* DC-SWITCH#2.8 # create vlan srvfarm-1
* DC-SWITCH#2.9 # configure vlan srvfarm-1 tag 1000
* DC-SWITCH#2.10 # configure vlan srvfarm-1 add port 49,50 tagged
* DC-SWITCH#2.11 # configure vlan srvfarm-1 add port 1 untagged
* DC-SWITCH#2.12 # configure eaps e5-domain add protect vlan srvfarm-1
```

Configuring an IP Address and OSPF on the Backbone VLAN. Configure an IP address and enable IP forwarding (routing) on the datacenter protected VLAN. This step is only performed on the core switch. Servers are configured accordingly with the core switch IP address as their default gateway. Since there are no additional routers on this VLAN, configure it as an OSPF passive interface. In this example, the datacenter VLAN is placed on the backbone OSPF area, but additional OSPF areas can be configured if needed.

Core-Switch#1 OSPF configuration:

```
* CORE-SWITCH#1.11 # configure vlan srvfarm-1 ipaddress 10.10.10.10/24
* CORE-SWITCH#1.12 # enable ipforwarding vlan srvfarm-1
* CORE-SWITCH#1.13 # configure ospf add vlan srvfarm-1 area 0.0.0.0 passive
```

Verifying EAPS and OSPF Configuration Status. Verify that the datacenter EAPS domain and OSPF configuration is correct. Verify whether the datacenter subnet is advertised to other routers through OSPF.

Core-Switch#2 route verification example:

```
* CORE-SWITCH#2.1 # show iproute 10.10.10.0/24
```

Ori	Destination	Gateway	Mtr	Flags	VLAN	Duration
#oa	10.10.10.0/24	192.168.1.1	6	UG-D---um--f	backbone	0d:0h:25m:5s

```
Origin(Ori): (b) BlackHole, (be) EGBP, (bg) BGP, (bi) IBGP, (bo) BOOTP
              (ct) CBT, (d) Direct, (df) DownIF, (dv) DVMRP, (e1) ISISL1Ext
              (e2) ISISL2Ext, (h) Hardcoded, (i) ICMP, (i1) ISISL1 (i2) ISISL2
              (is) ISIS, (mb) MBGP, (mbe) MBGPExt, (mbi) MBGPInter, (mp) MPLS Lsp
              (mo) MOSPF (o) OSPF, (o1) OSPFExt1, (o2) OSPFExt2
              (oa) OSPFIntra, (oe) OSPFAsExt, (or) OSPFInter, (pd) PIM-DM, (ps) PIM-SM
              (r) RIP, (ra) RtAdvrt, (s) Static, (sv) SLB_VIP, (un) UnKnown
              (*) Preferred unicast route (@) Preferred multicast route
              (#) Preferred unicast and multicast route
```

```
Flags: (B) BlackHole, (D) Dynamic, (G) Gateway, (H) Host Route
        (L) Matching LDP LSP, (l) Calculated LDP LSP, (m) Multicast
        (P) LPM-routing, (R) Modified, (S) Static, (s) Static LSP
        (T) Matching RSVP-TE LSP, (t) Calculated RSVP-TE LSP, (u) Unicast, (U) Up
        (f) Provided to FIB (c) Compressed Route
```

Mask distribution:

```
1 routes at length 16 1 routes at length 24
```

Route Origin distribution:

```
1 routes from OSPFIntra 1 routes from OSPFExt1
```

```
Total number of routes = 2
```

```
Total number of compressed routes = 0
```

Core-Switch#1 EAPS status:

```
* CORE-SWITCH#1.14 # show eaps
```

```
EAPS Enabled: Yes
EAPS Fast-Convergence: On
EAPS Display Config Warnings: On
EAPS Multicast Add Ring Ports: Off
EAPS Multicast Send IGMP Query: On
EAPS Multicast Temporary Flooding: Off
EAPS Multicast Temporary Flooding Duration: 15 sec
Number of EAPS instances: 2
# EAPS domain configuration :
```

```
-----
```

Domain	State	Mo	En	Pri	Sec	Control-Vlan	VID	Count
e5-domain	Links-Up	T	Y	2:1	2:4	control-5	(4005)	1
e6-domain	Complete	T	Y	4:1	4:2	control-6	(4006)	1

```
-----
```

Datacenter-Switch#1 EAPS status:

```
* DC-SWITCH#1.15 # show eaps
```

```
EAPS Enabled: Yes
EAPS Fast-Convergence: On
EAPS Display Config Warnings: On
EAPS Multicast Add Ring Ports: Off
EAPS Multicast Send IGMP Query: On
EAPS Multicast Temporary Flooding: Off
EAPS Multicast Temporary Flooding Duration: 15 sec
Number of EAPS instances: 1
# EAPS domain configuration :
```

```
-----
```

Domain	State	Mo	En	Pri	Sec	Control-Vlan	VID	Count
e6-domain	Links-Up	T	Y	49	50	control-6	(4006)	1

```
-----
```

Datacenter-Switch#2 EAPS status:

```
* DC-SWITCH#2.15 # show eaps
```

```
EAPS Enabled: Yes
EAPS Fast-Convergence: On
EAPS Display Config Warnings: On
EAPS Multicast Add Ring Ports: Off
EAPS Multicast Send IGMP Query: On
EAPS Multicast Temporary Flooding: Off
EAPS Multicast Temporary Flooding Duration: 15 sec
Number of EAPS instances: 1
# EAPS domain configuration :
```

```
-----
```

Domain	State	Mo	En	Pri	Sec	Control-Vlan	VID	Count
e6-domain	Links-Up	M	Y	49	50	control-6	(4006)	1

```
-----
```

Example EAPS and PBB Configuration

This section provides an example of how to configure a controller node to support EAPS and PBB. The example here can be modified to configure a partner node.

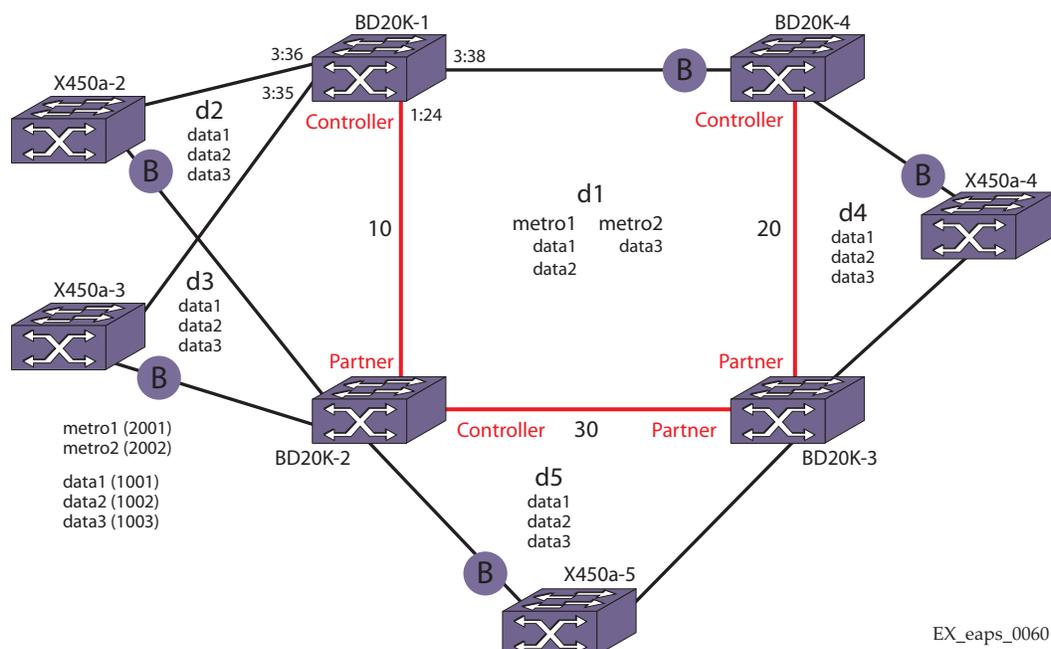


NOTE

Actual implementation steps on a production network may differ based on the physical topology, switch models, and software versions deployed.

Figure 132 shows a sample EAPS topology that supports PBB.

Figure 132: Sample EAPS Topology with PBB



In Figure 132, the CVLANs *data1*, *data2*, and *data3* are mapped to BVLANS *metro1* and *metro2*. This example details the configuration of switch *BD20K-1*, which is the controller node for common link *10*. To configure EAPS and PBB for switch *BD20K-1*, EAPS rings *d1*, *d2*, and *d3* must be configured.

After configuration is complete, switch *BD20K-1* recognizes that port *3:38* serves a BVLAN. If common link *10* fails, port *3:38* becomes the active-open port, and ports *3:35* and *3:36* enter the blocking state. If the link connected to port *3:38* fails, port *3:35* becomes the active-open port because it has the lowest port number. If port *3:38* recovers, it again becomes the active-open port.

The following sections list the commands required to configure EAPS and PBB for switch *BD20K-1* as shown in Figure 132:

- 1 [Configuring the CVLANs and BVLANS on page 990](#)
- 2 [Creating and Configuring the EAPS Domains on page 990](#)
- 3 [Creating and Configuring the EAPS Control VLANs on page 991](#)
- 4 [Configuring the Shared Port on page 991](#)
- 5 [Enabling EAPS on page 991](#)

Configuring the CVLANs and BVLANS

The following commands create the CVLANs and BVLANS:

```
# Create CVLANs
create cvlan data1
configure cvlan data1 tag 1001
configure cvlan data1 add port 3:35-36 tagged
create cvlan data2
configure cvlan data2 tag 1002
configure cvlan data2 add port 3:35-36 tagged
create cvlan data3
configure cvlan data3 tag 1003
configure cvlan data3 add port 3:35-36 tagged

# Create BVLANS
create bvlan metro1
configure bvlan metro1 tag 2001
configure bvlan metro1 add port 3:38, 1:24 tagged
create bvlan metro2
configure bvlan metro2 tag 2002
configure bvlan metro2 add port 3:38, 1:24 tagged

# Create ISIDs
create isid is1 1000
configure isid is1 add cvlan data1
create isid is2 2000
configure isid is2 add cvlan data2
create isid is3 3000
configure isid is3 add cvlan data3

# Bind ISIDs to BVLANS
configure bvlan metro1 add isid is1
configure bvlan metro1 add isid is2
configure bvlan metro2 add isid is3
```

Creating and Configuring the EAPS Domains

The following commands configure the EAPS domains:

```
create eaps d1
configure eaps d1 mode transit
configure eaps d1 primary port 1:24
configure eaps d1 secondary port 3:38
configure eaps d1 add control vlan vc1
configure eaps d1 add protected metro1
configure eaps d1 add protected metro2
create eaps d2
configure eaps d2 mode transit
configure eaps d2 primary port 1:24
configure eaps d2 secondary port 3:36
configure eaps d2 add control vlan vc2
configure eaps d2 add protected data1
configure eaps d2 add protected data2
configure eaps d2 add protected data3
create eaps d3
configure eaps d3 mode transit
```

```

configure eaps d3 primary port 1:24
configure eaps d3 secondary port 3:35
configure eaps d3 add control vlan vc3
configure eaps d3 add protected data1
configure eaps d3 add protected data2
configure eaps d3 add protected data3

```

Creating and Configuring the EAPS Control VLANs

The following commands configure the control VLANs:

```

create vlan vc1
configure vc1 tag 101
configure vc1 add port 3:38,1:24 tagged
create vlan vc2
configure vc2 tag 102
configure vc2 add port 3:36, 1:24 tagged
create vlan vc3
configure vc3 tag 103
configure vc3 add port 3:35, 1:24 tagged

```

Configuring the Shared Port

The following commands configure the shared port:

```

create eaps shared-port 1:24
configure eaps shared-port 1:24 link-id 10
configure eaps shared-port 1:24 mode controller

```

Enabling EAPS

The following commands enable EAPS on the switch and on the EAPS rings:

```

enable eaps
enable eaps d1
enable eaps d2
enable eaps d3

```

Displaying the EAPS Status

The following display commands show the example configuration and status after common link *10* fails:

```
Switch.2 # sh eaps shared-port 1:24
```

```

-----
Shared-port  Mode          Link          Domain Vlan   RB          RB
              Id    Up State      count  count Nbr State      Id
-----
1:24          Controller  10  Y  Blocking     3      5    Yes None     None
Segment Health Check interval:      1 sec
Segment Timeout:                      3 sec
Segment Fail Timer expiry action:    Send alert
Common Path Health Check interval:   1 sec
Common Path Timeout:                  3 sec

```

```

Segment Port: 3:35 Status: Up
  EAPS Domain:      d3
  Vlan-port count:  3
  Adjacent Blocking Id: None
  Segment RB Id:    None
Segment Port: 3:36 Status: Up
  EAPS Domain:      d2
  Vlan-port count:  3
  Adjacent Blocking Id: None
  Segment RB Id:    None
Segment Port: 3:38 Status: Up
  EAPS Domain:      d1
  Vlan-port count:  5
  Adjacent Blocking Id: None
  Segment RB Id:    None

```

```

Vlan: data1,          Vlan-port count: 3,    Active Open: 3:38 Bvlan: metro1
Vlan: data2,          Vlan-port count: 3,    Active Open: 3:38 Bvlan: metro1
Vlan: data3,          Vlan-port count: 3,    Active Open: 3:38 Bvlan: metro2
Vlan: metro1,         Vlan-port count: 1,    Active Open: 3:38
Vlan: metro2,         Vlan-port count: 1,    Active Open: 3:38

```

Switch.3 # sh eaps shared-port 1:24 detail

```

-----
Shared-port  Mode          Link      Domain Vlan      RB      RB
                Id  Up State  count  count Nbr State  Id
-----
1:24          Controller  10  Y  Blocking  3     5     Yes None  None

```

.
.

.

```

Vlan: data1,          Vlan-port count: 3,    Active Open: 3:38
  Segment Port  Bvlan          Virtual-port Status
    3:38  metro1          Active-Open
    3:35                    Blocked
    3:36                    Blocked

```

```

Vlan: data2,          Vlan-port count: 3,    Active Open: 3:38
  Segment Port  Bvlan          Virtual-port Status
    3:38  metro1          Active-Open
    3:35                    Blocked
    3:36                    Blocked

```

```

Vlan: data3,          Vlan-port count: 3,    Active Open: 3:38
  Segment Port  Bvlan          Virtual-port Status
    3:38 metro2          Active-Open
    3:35              Blocked
    3:36              Blocked

Vlan: metro1,        Vlan-port count: 1,    Active Open: 3:38
  Segment Port  Bvlan          Virtual-port Status
    3:38              Active-Open

Vlan: metro2,        Vlan-port count: 1,    Active Open: 3:38
  Segment Port  Bvlan          Virtual-port Status
    3:38              Active-Open

```

Switch.4 # sh eaps shared-port detail

EAPS shared-port count: 1

Shared-port	Mode	Link Id	Up	State	Domain count	Vlan count	RB Nbr	RB State	RB Id
1:24	Controller	10	Y	Blocking	3	5	Yes	None	None
.									
.									
.									

```

Vlan: data1,          Vlan-port count: 3,    Active Open: 3:38
  Segment Port  Bvlan          Virtual-port Status
    3:38 metro1          Active-Open
    3:35              Blocked
    3:36              Blocked

Vlan: data2,          Vlan-port count: 3,    Active Open: 3:38
  Segment Port  Bvlan          Virtual-port Status
    3:38 metro1          Active-Open
    3:35              Blocked
    3:36              Blocked

Vlan: data3,          Vlan-port count: 3,    Active Open: 3:38
  Segment Port  Bvlan          Virtual-port Status
    3:38 metro2          Active-Open
    3:35              Blocked
    3:36              Blocked

Vlan: metro1,        Vlan-port count: 1,    Active Open: 3:38
  Segment Port  Bvlan          Virtual-port Status
    3:38              Active-Open

Vlan: metro2,        Vlan-port count: 1,    Active Open: 3:38
  Segment Port  Bvlan          Virtual-port Status
    3:38              Active-Open

```

CFM Support in EAPS

ExtremeXOS provides Connectivity Fault Management (CFM) support within EAPS protocol. CFM reports fault connectivity failures to EAPS, and EAPS communicates with the CFM process to set up point-to-point DOWN MEPs (Management Endpoints) to monitor link connectivity. The CFM module notifies EAPS of any link-connectivity issues, and triggers EAPS to take necessary action.

802.1ag CFM supports link monitoring. It does this by sending out PDUs at designated transmit intervals. If the CFM fails to receive PDUs, it assumes the link is out of service, and notifies its clients. In this instance, EAPS acts as a CFM client.

First, you will create a down MEP within the CFM CLI. Configure the CLI to create a MEP group that associates this down MEP with a remote MEP (RMEP). There is a 1:1 relationship between a port and the down MEP, and as such, each MEP group is tied to a single port. Using the EAPS CLI, you can add the MEP groups you wish to monitor. For each MEP group added to EAPS, EAPS will receive UP/DOWN notifications from CFM when CFM detects a MEP state change for that group. Each MEP group corresponds to an EAPS ring port. Notifications from those MEP groups that are inadvertently added, that do not correspond to an EAPS ring port, are ignored in EAPS.

The CFM configuration is independent of EAPS, and MEPs and MEP groups may use different VLANs other than the EAPS control VLAN to monitor links.

When EAPS receives a CFM notification that the link failed, EAPS blocks that port on all of the EAPS control VLANs. This prevents EAPS control PDUs from being hardware forwarded on the link, in case the link is still up. Any EAPS PDUs that are received on a CFM failed port are dropped in EAPS.

Configuring EAPS for CFM Support

Use the following command to configure EAPS for CFM support. For additional configuration details for CFM support, refer to [“Configuring CFM” on page 413 in Chapter 9, “OAM”](#).

Bind To A MEP Group. To bind to a MEP Group, issue the following command:

```
configure eaps cfm [add | delete] group <group_name>
```

This command notifies CFM that EAPS is interested in notifications for this MEP and RMEP pair. This MEP should already be bound to a physical port, so when notification is received, EAPS associates that notification with a ring-port failure.

Creating MPs and the CCM Transmission Interval

Within an MA, you configure the following MPs:

- Maintenance end points (MEPs), which are one of the following types:
 - UP MEPs—transmit CCMs and maintain CCM database
 - DOWN MEPs—transmit CCMs and maintain CCM database
- Maintenance intermediate points (MIPs)—pass CCMs through

Each MEP must have an ID that is unique for that MEP throughout the MA.

To configure UP and DOWN MEPs and its unique MEP ID, use the following command:

```
configure cfm domain <domain_name> association <association_name> [ports <port_list>
add [[end-point [up|down] <mepid> {group <group_name>}] | [intermediate-point]]
```

To change the MEP ID on an existing MEP, use the following command:

```
configure cfm domain <domain-name> association <association_name> ports <port_list>
end-point [up | down] mepid <mepid>
```

To delete UP and DOWN MEPs, use the following command:

```
configure cfm domain <domain_name> association <association_name> [ports <port_list>]
delete [[end-point [up|down]] | [intermediate-point]]
```

To configure a MIP, use the following command:

```
configure cfm domain <domain_name> association <association_name> [ports <port_list>]
add [[end-point [up|down] <mepid> {group <group_name>}] | [intermediate-point]]
```

To delete a MIP, use the following command:

```
configure cfm domain <domain_name> association <association_name> [ports <port_list>]
delete [[end-point [up|down]] | [intermediate-point]]
```

To configure the transmission interval for the MEP to send CCMs, issue the following command:

```
configure cfm domain <domain_name> association <association_name> {ports <port_list>]
end-point [up | down]} transmit-interval [3|10|100|1000|10000|60000|600000]
```

To unconfigure the transmission interval for the MEP to send CCMs and return it to the default, use the following command:

```
unconfigure cfm domain <domain_name> association <association_name> {ports <port_list>]
end-point [up | down]} transmit-interval
```

To enable or disable a MEP, use the following command:

```
configure cfm domain <domain_name> association <association_name> ports <port_list>]
end-point [up | down] [enable | disable]
```

Display EAPS MEP Group Bindings. To display EAPS MEP group bindings, perform the following command:

```
show eaps cfm groups
X480-48t.2 # sh eaps cfm groups
```

```
-----
MEP Group Name                Status Port   MEP ID
-----
eapsCfmGrp1                   Up         41      11
eapsCfmGrp2                   Up         31      12
```

Display EAPS Output Change. To display EAPS output changes, issue the following command:

The existing `show eaps` output places a ! next to a CFM monitored ring port if the CFM indicates the MEP group for that port is down.

```
X480-48t.1 # sh eaps
```

```
EAPS Enabled: Yes
EAPS Fast-Convergence: Off
EAPS Display Config Warnings: Off
EAPS Multicast Add Ring Ports: Off
EAPS Multicast Send IGMP Query: On
```

```
EAPS Multicast Temporary Flooding: Off
EAPS Multicast Temporary Flooding Duration: 15 sec
Number of EAPS instances: 1
# EAPS domain configuration :
```

```
-----
Domain          State           Mo En Pri   Sec   Control-Vlan VID   Count Prio
-----
d2              Failed         M  Y !41   31    v2           (101 ) 1    N
-----
```

```
Flags : (!) CFM Down
```

Configuration Example

Here is a sample configuration of CFM support in EAPS:

```
X450a-48t.1 # sh configuration cfm
#
# Module dot1ag configuration.
#
create cfm domain string "MD1" md-level 6
configure cfm domain "MD1" add association string "MD1v1" vlan "v1"
configure cfm domain "MD1" add association string "MD1v2" vlan "v2"
configure cfm domain "MD1" association "MD1v1" ports 17 add end-point down 6
configure cfm domain "MD1" association "MD1v1" ports 23 add end-point down 5
configure cfm domain "MD1" association "MD1v2" ports 31 add end-point down 13
configure cfm domain "MD1" association "MD1v1" ports 17 end-point down add group
"eapsCfmGrp1"
configure cfm domain "MD1" association "MD1v1" ports 23 end-point down add group
"eapsCfmGrp2"
configure cfm domain "MD1" association "MD1v2" ports 31 end-point down add group
"eapsCfmGrp3"
configure cfm group "eapsCfmGrp1" add rmep 2
configure cfm group "eapsCfmGrp2" add rmep 4
configure cfm group "eapsCfmGrp3" add rmep 12
```

```
X450a-48t.2 # sh configuration "eaps"
#
# Module eaps configuration.
#
enable eaps
create eaps d1
configure eaps d1 mode transit
configure eaps d1 primary port 17
configure eaps d1 secondary port 23
enable eaps d1
create eaps d2
configure eaps d2 mode transit
configure eaps d2 primary port 31
configure eaps d2 secondary port 23
enable eaps d2
configure eaps d1 add control vlan v1
configure eaps d1 add protected vlan pv1
configure eaps d2 add control vlan v2
configure eaps d2 add protected vlan pv2
create eaps shared-port 23
```

```
configure eaps shared-port 23 mode partner
configure eaps shared-port 23 link-id 100
configure eaps cfm add group eapsCfmGrp1
configure eaps cfm add group eapsCfmGrp2
configure eaps cfm add group eapsCfmGrp3
```

Limitations

- CFM PDU transmit intervals are limited by the supported limits of CFM module. Platforms that do not support CFM in hardware are limited to a minimum interval of 100ms.
- The maximum number of down MEPs is limited by the CFM module. This is as low as 32 MEPs in some platforms. [See CFM scaling limitations in EXOS 1AG \(CFM\) Functional Spec.doc](#)

Platforms Supported

All EXOS platforms support this feature; however, not all platforms support hardware-based CFM. Platforms with no hardware-based CFM support are limited to software-based CFM transmit intervals of 100ms., or higher. Hardware-based intervals can go as low as 3.3ms.

Currently, only the x460 and E4G platforms support hardware-based CFM.

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CHAPTER

ERPS

This chapter includes the following sections:

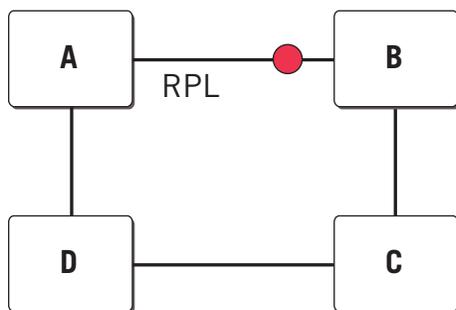
- [Overview on page 999](#)
- [Supported ERPS Features on page 1001](#)
- [Configuring ERPS on page 1001](#)
- [Sample Configuration on page 1003](#)
- [Debugging ERPS on page 1005](#)
- [Deferred ERPS Features on page 1005](#)

Overview

The basic concept of G.8032/ERPS is that traffic may flow on all links of a ring network except on one link called the Ring Protection Link (RPL). The RPL owner is the node that blocks the RPL, and the other node of the RPL is called the RPL neighbor node. All other nodes are called non-RPL nodes. When a link fails, the RPL owner unblocks the RPL to allow connectivity to the nodes in the ring. The G.8032/ERPS rings utilize a channel (dedicated path) for carrying their control traffic which is the R-APS messages (Ring Automatic Protection Switching).

The ring protection architecture relies on the existence of an APS protocol to coordinate ring protection actions around an Ethernet ring, as shown in [Figure 133](#).

Figure 133: Simple Ring with RPL, RPL Owner, RPL Neighbor, and Non-RPL Nodes



EX_0250

More complex topologies include ladder ring networks which are called sub-rings in G.8032 terminology. In G.8032 networks, there could exist one or more rings and sub-rings which complete their connectivity through the interconnected nodes of the ring(s). Multiple ladder networks are supported only if the following conditions are met.

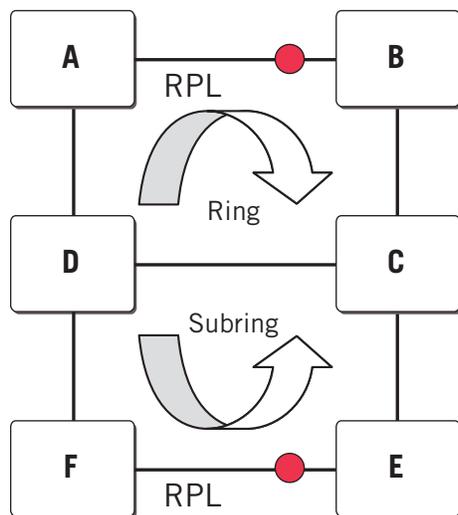
- R-APS channels are not shared across Ethernet ring interconnections.
- On each ring port, each traffic channel and each R-APS channel are controlled by the Ethernet Ring Protection Control Process (ERP Control Process) of only one Ethernet ring.
- Each major ring or sub-ring must have its own RPL.

**NOTE**

One important aspect of sub-rings is that the sub-ring completes its channel through the virtual channel (when using the virtual channel mode), which can span the network and cross the sub-ring boundaries. This entails that the virtual channel is provisioned on all the nodes it spans across.

In [Figure 134](#), the ring comprises nodes A, B, C, and D with links A-B, B-C, C-D, and D-A while the control channel for this ring has its own dedicated vlan. The sub-ring consists of nodes D, F, E, and C with links D-F, F-E, and E-C. D and C are interconnected nodes. The channel for the sub-ring spans the links C-E, E-F, and F-D and their nodes while the virtual channel comprises the links D-A, A-B, B-C and D-C and their nodes. This means that the virtual channel for the sub-ring needs to not only exist on the interconnected nodes, but also on the nodes A and B.

Figure 134: Ring and Sub-ring Network



EX_0251

When using G.8032 in networks, take care to design the virtual channel paths, since the VLAN provisioning has to exist on all the nodes through which the virtual channel can pass and which is solely dedicated to the sub-ring in question.

Sub-ring topology changes may impact flow forwarding over the domain of the other (interconnected) network, as such topology change events are signalled to the domain of the other network using the Topology Change signal.

Supported ERPS Features

The following are the ERPS features supported in the current release:

- G.8032 version 1 support.
- G.8032 version 2 support with a restricted VC option.
- Revertive mode support for version 1 and 2.
- Basic interoperability with EAPS with G.8032 acting as an access ring. Flush notifications will be sent Link monitoring using CFM or native local link monitoring methods.
- Support for hardware accelerated CFM in specific platforms that have this capability.

Configuring ERPS

This section includes an overview of the commands available for configuring ERPS Version 1 features and the supported ERPS Version 2 features.

- [ERPS Version 1 Commands on page 1001](#)
- [ERPS Version 2 Commands on page 1003](#)

ERPS Version 1 Commands

To create or delete an ERPS ring, use the following commands:

```
create erps <ring-name>
delete erps <ring-name>
```

To add or delete a control VLAN on the ERPS ring, use the following commands:

```
configure erps <ring-name> add control {vlan} <vlan-name>
configure erps <ring-name> delete control {vlan} <vlan-name>
```

To add or delete a protected VLAN on the ERPS ring, use the following commands:

```
configure erps <ring-name> add protected {vlan} <vlan-name>
configure erps <ring-name> delete protected {vlan} <vlan-name>
```

To add ring ports on the ERPS ring, use the following command:

```
configure erps <ring-name> ring-ports [east | west] <port>
```

To delete ring ports on the ERPS ring, use the following command:

```
unconfigure erps <ring-name> ring-ports west
```

To add or delete RPL (ring protection link) owner configuration for the ERPS ring, use the following commands:

```
configure erps <ring-name> protection-port <port>
unconfigure erps <ring-name> protection-port
```

To add or delete RPL (ring protection link) neighbor configuration for the ERPS ring, use the following commands:

```
configure erps <ring-name> neighbor-port <port>
unconfigure erps <ring-name> neighbor-port
```

To add or delete ERPS revert operation along with the “wait-to-restore” time interval, use the following command:

```
configure {erps} <ring-name> revert [ enable | disable ]
```

To configure the periodic timer, use the following command:

```
configure {erps} <ring-name> timer periodic [ default | <milliseconds> ]
```

To configure the guard timer, use the following command:

```
configure {erps} <ring-name> timer guard [ default | <milliseconds> ]
```

To configure the hold-off timer, use the following command:

```
configure {erps} <ring-name> timer hold-off [ default | <milliseconds> ]
```

To configure the wait-to-restore timer, use the following command:

```
configure {erps} <ring-name> timer wait-to-restore [ default | <milliseconds> ]
```

To associate and disassociate fault monitoring entities on the ERPS ring ports, use the following commands:

```
configure erps <ring-name> cfm md-level <level>
configure erps <ring-name> cfm port [east | west] ccm-interval [100 | 1000 | 10000 |
60000 | 600000]
configure erps <ring-name> cfm port [east | west] mepid <mepid> remote-mepid <rmepid>
unconfigure {erps} <ring-name> cfm
```

To rename the ERPS ring/sub-ring, use the following command:

```
configure erps <old-ring-name> name <new-ring-name>
```

To enable or disable ERPS, use the following commands:

```
enable erps
disable erps
```

To enable or disable an existing ERPS ring/sub-ring, use the following commands:

```
enable erps <ring-name>
disable erps <ring-name>
```

To run or clear force and manual switch triggers to the ERPS ring/sub-ring, use the following command:

```
configure erps <ring-name> dynamic-state [force-switch | manual-switch | clear] port
<slot:port>
```

To display global information for ERPS, use the following command:

```
show erps
```

To display specific details about an ERPS ring, use the following command:

```
show erps <ring-name>
```

To display ERPS statistics, use the following command:

```
show erps <ring-name> statistics
```

To clear statistics on an ERPS ring, use the following command:

```
clear counters erps <ring-name>
```

To debug ERPS, use the following commands:

```
debug erps [options]
debug erps show <ring-name>
```

ERPS Version 2 Commands

To set the rings to which to propagate topology change events, use the following command:

```
configure erps <ring-name> [add | delete] topology-change <ring-list>
```

To add or delete a sub-ring to the main ring, use the following command:

```
configure {erps} <ring-name> [add | delete] sub-ring-name <sub_ring>
```

To add or delete an ERPS sub-ring to the EAPS domain, use the following commands:

```
configure {erps} <ring-name> notify-topology-change {eaps} <domain_name>
unconfigure {erps} <ring-name> notify-topology-change {eaps} <domain_name>
```

To configure a wait-to-block timer, use the following command:

```
configure {erps} <ring-name> timer wait-to-block [ default | <milliseconds>]
```

To enable or disable the ability of ERPS to allow the topology-change bit to be set (to send out Flush events), use the following commands:

```
enable erps <ring-name> topology-change
disable erps <ring-name> topology-change
```

Sample Configuration

The following is a sample ERPS configuration:

```
create vlan cv1
config vlan cv1 tag 10
config vlan cv1 add port 5 6 tagged

create vlan pv1
config vlan pv1 tag 1000
config vlan pv1 add port 5 6 tagged

create erps ring1
configure erps ring1 ring-ports east 5
configure erps ring1 ring-ports west 6
configure erps ring1 add control "cv1"
configure erps ring1 add protected vlan "pv1"
configure erps ring1 add protection-port 5
configure erps ring1 revert enable wait-to-restore 500
configure erps ring1 timer wait-to-restore 500
enable erps ring1
enable erps
```

CFM Down-MEP Configuration to Provide Link Monitoring/ Notifications

```

disable erps ring1
config erps ring1 cfm md-level 6
config erps ring1 cfm port east ccm-interval 100
config erps ring1 cfm port east mepid 1 remote-mepid 3
config erps ring1 cfm port west ccm-interval 100
config erps ring1 cfm port west mepid 2 remote-mepid 4
enable erps ring1

```

Sub-ring Configuration

First configure a main ring on the interconnected node:

```

create vlan Major_Cv1
configure vlan Major_Cv1 tag 300
configure vlan Major_Cv1 add ports 1 3 tag

create vlan Major_Pv1
configure vlan Major_Pv1 tag 301
configure vlan Major_Pv1 add ports 1 3 27 tag

create erps Major
configure erps Major add control Major_Cv1
configure erps Major add protected vlan Major_Pv1
configure erps Major ring-port east 1
configure erps Major ring-port west 3
configure erps Major protection-port 1
configure erps Major cfm md-level 2
configure erps Major cfm port east mepid 1 remote-mepid 3
configure erps Major cfm port west mepid 2 remote-mepid 4
enable erps Major
enable erps

```

Next configure a sub-ring on the interconnected node:

```

create vlan Sub_Cv1
configure vlan Sub_Cv1 tag 299
configure vlan Sub_Cv1 add ports 1 3 27 tag

create erps Sub1
configure erps Sub1 add control Sub_Cv1
configure erps Sub1 add protected vlan Major_Pv1
configure erps Sub1 ring-port east 27
configure erps Sub1 protection-port 27
configure erps Major add sub-ring Sub1
configure erps Sub1 cfm md-level 3
configure erps Sub1 cfm port east mepid 1 remote-mepid 2
enable erps Sub1
enable erps

```

Virtual Channel for Sub-ring

```
configure erps <ring-name> add protected {vlan} <vlan-name>
```

Debugging ERPS

Also, check the output of “show erps” and “show erps <ring>” to see if the node state is as expected. In steady state, the node should be in “Idle” and the failed state ring should be in “Protected” state.

Check the output of “show erps <ring> statistics” to see if any error/dropped counters are incrementing. If they are, check the state of the ring ports and trace these links to the neighbor node to see the state of the links. The output of “show log” after turning on the filters for ERPS should provide more information on what is happening on the switch.

Deferred ERPS Features

These are the deferred features for ERPS in the current release:

- Full ERPS Version 2 support is deferred to a later release. This includes all sub-ring support and their required configuration with or without Virtual Channels and options to use CFM UP-MEPs and so forth.
- Non-revertive mode, Manual and Force switch options are not available in the current release.
- Backup MSM Failover and checkpointing for both v1 and v2 are not available in the current release.
- In platforms that do not have hardware OAM (operations and management), the most optimum CFM interval recommended is 1 second for link monitoring, which will give rise to approximately 3 second overhead in convergence times.
- Optimizations done in EAPS for VPLS and any other within EAPS will be taken up in future releases.
- Other than the basic EAPS interoperability stated above, all other EAPS related interoperability will be deferred to a later release.
- There is no interoperability with STP in the current release.
- SNMP is not supported in the current release.

27 STP

CHAPTER

This chapter includes the following sections:

- [Overview on page 1007](#)
- [Spanning Tree Domains on page 1014](#)
- [STP Configurations on page 1024](#)
- [Per VLAN Spanning Tree on page 1030](#)
- [Rapid Spanning Tree Protocol on page 1030](#)
- [Multiple Spanning Tree Protocol on page 1042](#)
- [STP and Network Login on page 1053](#)
- [STP Rules and Restrictions on page 1054](#)
- [Configuring STP on the Switch on page 1055](#)
- [Displaying STP Settings on page 1057](#)

Using the Spanning Tree Protocol (STP) functionality of the switch makes your network more fault tolerant. This chapter explains more about STP and the STP features supported by ExtremeXOS.



NOTE

STP is a part of the 802.1D bridge specification defined by the IEEE Computer Society. To explain STP in terms used by the IEEE 802.1D specification, the switch will be referred to as a bridge.

ExtremeXOS version 12.0 and later supports the new edition of the IEEE 802.1D standard (known as IEEE 802.1D-2004) for STP, which incorporates enhancements from the IEEE 802.1t-2001, IEEE 802.1W, and IEEE 802.1y standards. The IEEE 802.1D-2004 standard is backward compatible with the IEEE 802.1D-1998 standard. For more information, see [“Compatibility Between IEEE 802.1D-1998 and IEEE 802.1D-2004 STP Bridges” on page 1008](#).

Overview

STP is a bridge-based mechanism for providing fault tolerance on networks. STP allows you to implement parallel paths for network traffic and to ensure that redundant paths are:

- Disabled when the main paths are operational.
- Enabled if the main path fails.

**NOTE**

STP and Extreme Standby Router Protocol (ESRP) cannot be configured on the same VLAN simultaneously.

Compatibility Between IEEE 802.1D-1998 and IEEE 802.1D-2004 STP Bridges

The IEEE 802.1D-2004 compliant bridges interoperate with the IEEE 802.1D-1998 compliant bridges. To ensure seamless operation of your STP network, read this section before you configure STP on any Extreme Networks device running ExtremeXOS 11.6 or later.

Differences in behavior between the two standards include the:

- Default port path cost
- Bridge priority
- Port priority
- Edge port behavior

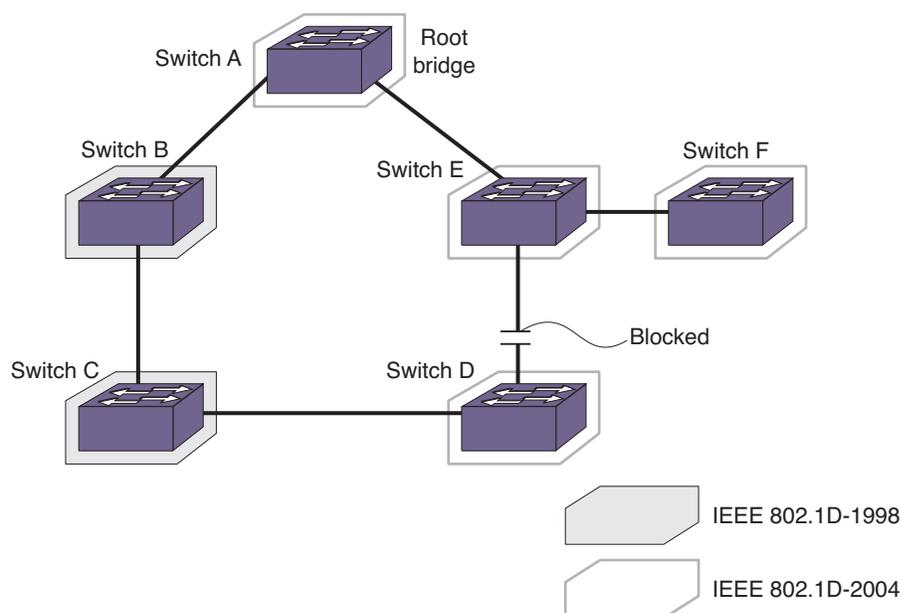
This section describes the bridge behavior differences in more detail.

Default Port Path Cost

The 802.1D-2004 standard modified the default port path cost value to allow for higher link speeds. A higher link speed can create a situation whereby an 802.1D-1998 compliant bridge could become the more favorable transit path.

For example, in [Figure 135](#), bridge A is the root bridge running the new 802.1D-2004 standard, bridges B and C are running the old 802.1D-1998 standard, and bridges D, E, and F are running the new 802.1D-2004 standard. In addition, all ports are 100 Mbps links. The ports on bridges B and C have a default path cost of 19, and the ports on bridge A, D, E, and F have a default path cost of 200,000.

Figure 135: 802.1D-1998 and 802.1D-2004 Mixed Bridge Topology



EX_179

If you use the default port path costs, bridge D blocks its port to bridge E, and all traffic between bridges D and E must traverse all of bridges in the network. Bridge D blocks its port to bridge E because the path cost to the root bridge is less by going across bridges B and C (with a combined root cost of 38) compared with going across bridge E (with a root cost of 200,000). In fact, if there were 100 bridges between bridges B, C, and D running the old 802.1D-1998 standard with the default port path costs, bridge D would still use that path because the path cost is still higher going across bridge E.

As a workaround and to prevent this situation, configure the port path cost to make links with the same speed use the same path cost value. In the example described above, configure the port path cost for the 802.1D-2004 compliant bridges (bridges A, D, E, and F) to 19.

**NOTE**

You cannot configure the port path cost on bridges B and C to 200,000 because the path cost range setting for 802.1D-1998 compliant bridges is 1 to 65,535.

To configure the port path cost, use the following command:

```
configure stpd <stpd_name> ports cost [auto | <cost>] <port_list>
```

Bridge Priority

By configuring the STPD bridge priority, you make the bridge more or less likely to become the root bridge. Unlike the 802.1D-1998 standard, the 802.1D-2004 standard restricts the bridge priority to a 16-bit number that must be a multiple of 4,096. The new priority range is 0 to 61,440 and is subject to the multiple of 4,096 restriction. The old priority range was 0 to 65,535 and was not subject to the multiple

of 4,096 restriction (except for MSTP configurations). The default bridge priority remains the same at 32,768.

If you have an ExtremeXOS 11.5 or earlier configuration that contains an STP or RSTP bridge priority that is not a multiple of 4,096, the switch rejects the entry and the bridge priority returns to the default value while loading the structure. The MSTP implementation in ExtremeXOS already uses multiples of 4,096 to determine the bridge priority.

To configure the bridge priority, use the following command:

```
configure stpd <stpd_name> priority <priority>
```

For example, to lower the numerical value of the priority (which gives the priority a higher precedence), you subtract 4,096 from the default priority: $32,768 - 4,096 = 28,672$. If you modify the priority by a value other than 4,096, the switch automatically changes the priority to the lower priority value. For example, if you configure a priority of 31,000, the switch automatically changes the priority to 28,672.

Port Priority

The port priority value is always paired with the port number to make up the 16-bit port identifier, which is used in various STP operations and the STP state machines. Unlike the 802.1D-1998 standard, the 802.1D-2004 standard uses only the four most significant bits for the port priority and it must be a multiple of 16. The new priority range available is 0 to 240 and is subject to the multiple of 16 restriction. The 802.1D-1998 standard uses the eight most significant bits for the port priority. The old priority range was 0 to 31 and was not subject to the multiple of 16 restriction.

To preserve backward compatibility and to use ExtremeXOS 11.5 or earlier configurations, the existing `configure stpd ports priority` command is available. If you have an ExtremeXOS 11.5 or earlier configuration, the switch interprets the port priority based on the 802.1D-1998 standard. If the switch reads a value that is not supported in ExtremeXOS 11.6 or later, the switch rejects the entry.

When you save the port priority value, the switch saves it as the command `configure stpd ports port-priority` with the corresponding change in value.

For example, if the switch reads the `configure stpd ports priority 16` command from an ExtremeXOS 11.5 or earlier configuration, (which is equivalent to the command `configure stpd ports priority 8` entered through CLI), the switch saves the value as `configure stpd ports port-priority 128`.

Edge Port Behavior

In ExtremeXOS 11.5 or earlier, Extreme Networks had two edge port implementations: edge port and edge port with safeguard. The 802.1D-2004 standard has a bridge detection state machine, which introduced a third implementation of edge port behavior. The following list describes the behaviors of the different edge port implementations:

- Edge port (ExtremeXOS 11.5 and earlier):
 - The port does not send BPDUs
 - The port does not run a state machine
 - If BPDUs are received, the port discards the BPDU and enters the blocking state
 - If subsequent BPDUs are not received, the port remains in the forwarding state

- Edge port with safeguard configured (ExtremeXOS 11.5 and 11.4 only):
 - The port sends BPDUs
 - When configured for MSTP, the port runs a partial state machine
 - If BPDUs are received, the port enters the blocking state
 - If subsequent BPDUs are not received, the port attempts to enter the forwarding state
- Edge port running 802.1D-2004 with safeguard enabled:
 - The port sends BPDUs
 - The port runs a state machine
 - If BPDUs are received, the port behaves as a normal RSTP port by entering the forwarding state and participating in RSTP
 - If subsequent BPDUs are not received, the port attempts to become the edge port again

Edge port with safeguard prevents accidental or deliberate misconfigurations (loops) by having edge ports enter the blocking state upon receiving a BPDU. The 802.1D-2004 standard implements a bridge detection mechanism that causes an edge port to transition to a non-edge port upon receiving a BPDU; however, if the former edge port does not receive any subsequent BPDUs during a pre-determined interval, the port attempts to become an edge port.

If an 802.1D-2004 compliant safeguard port (edge port) connects to an 802.1D-1998 compliant edge port with safeguard configured, the old safeguard port enters the blocking state. Although the new safeguard port becomes a designated port, the link is not complete (and thus no loop is formed) because one side of the link is blocked.

Restricted Role

In a large metro environment, to prevent external bridges from influencing the spanning tree active topology, the following commands have been introduced for Rapid Spanning Tree Protocol (RSTP) and Multiple Spanning Tree Protocol (MSTP).

- `configure stpd <stpd_name> ports restricted-role enable <port_list>`
 - This command enables restricted role on a specified port in the core network to prevent external bridges from influencing the spanning tree active topology.
 - Restricted role should not be enabled with edge mode.
 - `stpd_name`—Specifies an STPD name on the switch.
 - `port_list`—Specifies one or more ports or slots and ports.
 - Enabling restricted role causes a port to not be selected as a root port, even if it has the best spanning tree priority vector. Such a port is selected as an alternate port after the root port is selected. The restricted role is disabled by default. If set, it can cause a lack of spanning tree connectivity.
 - A network administrator enables restricted role to prevent external bridges from influencing the spanning tree active topology.
- `configure stpd <stpd_name> ports restricted-role disable <port_list>`
 - This command disables restricted role on a specified port in the core network.
 - `stpd_name`—Specifies an STPD name on the switch.

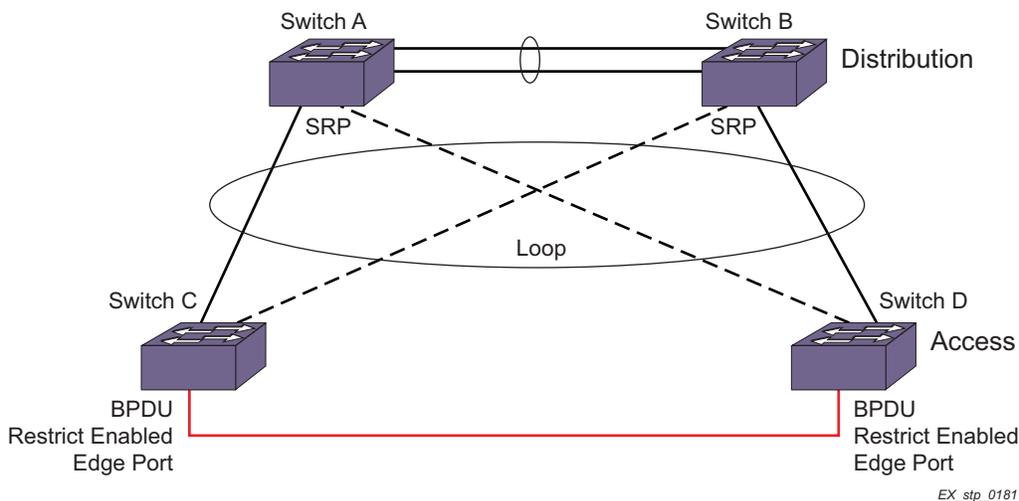
- `port_list`—Specifies one or more ports or slots and ports.
- Restricted role is disabled by default. If set, it can cause a lack of spanning tree connectivity. A network administrator enables restricted role to prevent external bridges from influencing the spanning tree active topology.

BPDU Restrict on Edge Safeguard

BPDU restrict causes a port on which this feature is configured to be disabled as soon as an STP BPDU is received on that port thus allowing you to enforce the STP domain borders and keep the active topology predictable.

Figure 136 shows a BPDU restrict example.

Figure 136: BPDU Restrict



In this figure, loops on the LAN access switches are not prevented since the ports towards the distribution switches are not running STP but Software Redundant Ports (SRP). Currently, ExtremeXOS software cannot run STP on ports that are configured for SRP. STP on the access switch is unaware of the alternate path and therefore cannot prevent the loop that exists across the switches. Configuring a port as an edge mode port alone cannot prevent the loop between the switches because edge ports never send BPDUs. The edge safeguard feature is not able to prevent the loops because STP does not have the information about the alternate path.

To prevent the loops across the switches, the edge safeguard feature can be configured with the BPDU restrict function. When running in BPDU restrict mode, edge safeguard ports send STP BPDUs at a rate of 1 every 2 seconds. The port is disabled as soon as an STP BPDU is received on the BPDU restrict port, thereby preventing the loop. Flexibility is provided with an option to re-enable the port after a user specified time period. If a user enables a port while STP has disabled it, the port is operationally enabled; STP is notified and then stops any recovery timeout that has started.

When an STPD is disabled for a BPDU restrict configured port, an STP port in 802.1D operation mode begins forwarding immediately, but in the RSTP or MSTP operation modes, the port remains in the disabled state.

BPDU restrict is available on all of the three operational modes of STP: 802.1D, RSTP, and MSTP.

Although edge safeguard is not available in 802.1D operation mode, when you configure BPDU restrict you do so in a similar way, that is, as an extension of edge safeguard; then only BPDU restrict is available on the port and not edge safeguard.

To configure BPDU restrict, use the following command:

```
configure {stpd} <stpd_name> ports edge-safeguard enable <port_list> {bpdu-restrict}
{recovery-timeout <seconds>}}
```

BPDU restrict can also be configured by using the following commands:

```
configure {stpd} <stpd_name> ports bpdu-restrict [enable | disable] <port_list>
{recovery-timeout <seconds>}}
```

```
configure stpd <stpd_name> ports link-type [[auto | broadcast | point-to-point]
<port_list> | edge <port_list> {edge-safeguard [enable | disable] {bpdu-restrict}
{recovery-timeout <seconds>}}]
```

To include BPDU restrict functionality when configuring link types or edge safeguard, see [Configuring Link Types](#) and [“Configuring Edge Safeguard” on page 1033](#).

Following shows a BPDU restrict configuration:

```
* X450a-24t.1# configure s1 ports edge-safeguard enable 9 bpdu-restrict recovery-
timeout 400.
```

Following is sample output from the `show s1 ports` command resulting from the configuration:

```
X450a-24t.35 # show s1 ports
Port  Mode  State      Cost  Flags      Priority Port ID Designated Bridge
9      EMISTP FORWARDING 20000 eDee-w-G-- 128      8009      80:00:00:04:96:26:5f:4e
```

Total Ports: 1

```
----- Flags: -----
1:          e=Enable, d=Disable
2: (Port role)  R=Root, D=Designated, A=Alternate, B=Backup, M=Master
3: (Config type) b=broadcast, p=point-to-point, e=edge, a=auto
4: (Oper. type)  b=broadcast, p=point-to-point, e=edge
5:          p=proposing, a=agree
6: (partner mode) d = 802.1d, w = 802.1w, m = mstp
7:          i = edgeport inconsistency
8:          S = edgeport safe guard active
          s = edgeport safe guard configured but inactive
8:          G = edgeport safe guard bpdu restrict active in 802.1w and mstp
          g = edgeport safe guard bpdu restrict active in 802.1d
9:          B = Boundary, I = Internal
10:         r = Restricted Role
```

```
X450a-24t.5 # show configuration stp
#
# Module stp configuration.
#
configure mstp region 000496265f4e
configure stpd s0 delete vlan default ports all
disable stpd s0 auto-bind vlan default
create stpd s1
configure stpd s1 mode dot1w
enable stpd s0 auto-bind vlan Default
```

```
configure stpd s1 add vlan v1 ports 9 emistp
configure stpd s1 ports mode emistp 9
configure stpd s1 ports cost auto 9
configure stpd s1 ports port-priority 128 9
configure stpd s1 ports link-type edge 9
configure stpd s1 ports edge-safeguard enable 9 recovery-timeout 400
configure stpd s1 ports bpdu-restrict enable 9 recovery-timeout 400
enable stpd s1 ports 9
configure stpd s1 tag 10
enable stpd s1
```

Following is sample output for STP operation mode dot1d from the show configuration "stp" command:

```
X450a-24t.22 # show configuration stp
#
# Module stp configuration.
#
configure mstp region region2
configure stpd s0 delete vlan default ports all
disable stpd s0 auto-bind vlan default
create stpd s1
enable stpd s0 auto-bind vlan Default
configure stpd s1 add vlan v1 ports 9 emistp
configure stpd s1 ports mode emistp 9
configure stpd s1 ports cost auto 9
configure stpd s1 ports priority 16 9
configure stpd s1 ports link-type edge 9
configure stpd s1 ports edge-safeguard enable 9 recovery-timeout 400
configure stpd s1 ports bpdu-restrict enable 9 recovery-timeout 400
enable stpd s1 ports 9
configure stpd s1 tag 10
enable stpd s1
```

Spanning Tree Domains

The switch can be partitioned into multiple virtual bridges. Each virtual bridge can run an independent Spanning Tree instance. Each Spanning Tree instance is called a *Spanning Tree Domain* (STPD). Each STPD has its own root bridge and active path. After an STPD is created, one or more VLANs can be assigned to it.

A physical port can belong to multiple STPDs. In addition, a VLAN can span multiple STPDs.

The key points to remember when configuring VLANs and STP are:

- Each VLAN forms an independent broadcast domain.
- STP blocks paths to create a loop-free environment.
- Within any given STPD, all VLANs belonging to it use the same spanning tree.

To create an STPD, use the following command:

```
create stpd <stpd_name> {description <stpd-description>}
```

To delete an STPD, use the following command:

```
delete stpd <stpd_name>
```

User-created STPD names are not case-sensitive.

For detailed information about configuring STP and various STP parameters on the switch, see [“Configuring STP on the Switch” on page 1055](#).

The remainder of this section describes the following topics:

- [Member VLANs on page 1015](#)
- [STPD Modes on page 1016](#)
- [Encapsulation Modes on page 1017](#)
- [STP States on page 1018](#)
- [Binding Ports on page 1019](#)
- [Rapid Root Failover on page 1021](#)
- [STPD BPDU Tunneling on page 1021](#)
- [STP and Hitless Failover—Modular Switches Only on page 1023](#)

Member VLANs

When you add a VLAN to an STPD, that VLAN becomes a member of the STPD. The two types of member VLANs in an STPD are:

- Carrier
- Protected

Carrier VLAN

A carrier VLAN defines the scope of the STPD, which includes the physical and logical ports that belong to the STPD and if configured, the 802.1Q tag used to transport Extreme Multiple Instance Spanning Tree Protocol (EMISTP) or Per VLAN Spanning Tree (PVST+) encapsulated bridge protocol data units (BPDUs) (see [“Encapsulation Modes” on page 1017](#) for more information about encapsulating STP BPDUs). Only one carrier VLAN can exist in a given STPD, although some of its ports can be outside the control of any STPD at the same time.

If you configure EMISTP or PVST+, the STPD ID must be identical to the VLAN ID of the carrier VLAN in that STPD. See [“Specifying the Carrier VLAN” on page 1016](#) for an example.

If you have an 802.1D configuration, Extreme Networks recommends that you configure the StpdID to be identical to the VLAN ID of the carrier VLAN in that STPD. See [“Basic 802.1D Configuration Example” on page 1058](#) for an example.

If you configure Multiple Spanning Tree (MSTP—IEEE 802.1Q-2003, formerly IEEE 802.1s) you do not need carrier VLANs for MSTP operation. With MSTP, you configure a Common and Internal Spanning Tree (CIST) that controls the connectivity of interconnecting MSTP regions and sends BPDUs across the regions to communicate the status of MSTP regions. All VLANs participating in the MSTP region have the same privileges. For more information about MSTP, see [“Multiple Spanning Tree Protocol” on page 1042](#).

Protected VLAN

Protected VLANs are all other VLANs that are members of the STPD. These VLANs “piggyback” on the carrier VLAN. Protected VLANs do not transmit or receive STP BPDUs, but they are affected by STP

state changes and inherit the state of the carrier VLAN. Protected VLANs can participate in multiple STPDs, but any particular port in the VLAN can belong to only *one* STPD. Also known as non-carrier VLANs.

If you configure MSTP, all member VLANs in an MSTP region are protected VLANs. These VLANs do not transmit or receive STP BPDUs, but they are affected by STP state changes communicated by the CIST to the MSTP regions. Multiple spanning tree instances (MSTIs) cannot share the same protected VLAN; however, any port in a protected VLAN can belong to multiple MSTIs. For more information about MSTP, see [“Multiple Spanning Tree Protocol” on page 1042](#).

Specifying the Carrier VLAN

The following example:

- Creates and enables an STPD named *s8*.
- Creates a carrier VLAN named *v5*.
- Assigns VLAN *v5* to STPD *s8*.
- Creates the same tag ID for the VLAN and the STPD (the carrier VLAN's ID must be identical to the STPD's ID).

```
create vlan v5
configure vlan v5 tag 100
configure vlan v5 add ports 1:1-1:20 tagged
create stpd s8
configure stpd s8 add vlan v5 ports all emistp
configure stpd s8 tag 100
enable stpd s8
```

Notice how the tag number for the VLAN *v5* and the STPD *s8* is identical (the tag is 100). By using identical tags, you have selected the carrier VLAN. The carrier VLAN's ID is identical to the STPD's ID.

STPD Modes

An STPD has three modes of operation:

- **802.1D mode**
Use this mode for backward compatibility with previous STP versions and for compatibility with third-party switches using IEEE standard 802.1D. When configured in this mode, all rapid configuration mechanisms are disabled.
- **802.1w mode**
Use this mode for compatibility with Rapid Spanning Tree (RSTP). When configured in this mode, all rapid configuration mechanisms are enabled. The benefit of this mode is available on point-to-point links only and when the peer is likewise configured in 802.1w mode. If you do not select point-to-point links and the peer is not configured for 802.1w mode, the STPD fails back to 802.1D mode.
You enable or disable RSTP on a per STPD basis only. You do not enable RSTP on a per port basis. For more information about RSTP and RSTP features, see [“Rapid Spanning Tree Protocol” on page 1030](#).
- **MSTP mode**
Use this mode for compatibility with MSTP. MSTP is an extension of RSTP and offers the benefit of better scaling with fast convergence. When configured in this mode, all rapid configuration

mechanisms are enabled. The benefit of MSTP is available only on point-to-point links and when you configure the peer in MSTP or 802.1w mode. If you do not select point-to-point links and the peer is not configured in 802.1w mode, the STPD fails back to 802.1D mode.

You must first configure a CIST before configuring any MSTIs in the region. You cannot delete or disable a CIST if any of the MSTIs are active in the system.

You create only one MSTP region on the switch, and all switches that participate in the region must have the same regional configurations. You enable or disable an MSTP on a per STPD basis only. You do not enable MSTP on a per port basis.

If configured in MSTP mode, an STPD uses the 802.1D BPDU encapsulation mode by default. To ensure correct operation of your MSTP STPDs, do not configure EMISTP or PVST+ encapsulation mode for MSTP STPDs.

For more information about MSTP and MSTP features, see [“Multiple Spanning Tree Protocol” on page 1042](#).

By default:

- The STPD operates in 802.1D mode.
- The default device configuration contains a single STPD called *s0*.
- The default VLAN is a member of STPD *s0* with autobind enabled.

To configure the mode of operation of an STPD, use the following command:

```
configure stpd <stpd_name> mode [dot1d | dot1w | mstp [cist | msti <instance>]]
```

All STP parameters default to the IEEE 802.1D values, as appropriate.

Encapsulation Modes

You can configure ports within an STPD to accept specific BPDU encapsulations. This STP port encapsulation is separate from the STP mode of operation. For example, you can configure a port to accept the PVST+ BPDU encapsulation while running in 802.1D mode.

An STP port has three possible encapsulation modes:

- 802.1D mode

Use this mode for backward compatibility with previous STP versions and for compatibility with third-party switches using IEEE standard 802.1D. BPDUs are sent untagged in 802.1D mode. Because of this, any given physical interface can have only *one* STPD running in 802.1D mode.

This encapsulation mode supports the following STPD modes of operation: 802.1D, 802.1w, and MSTP.
- Extreme Multiple Instance Spanning Tree Protocol (EMISTP) mode

EMISTP mode is proprietary to Extreme Networks and is an extension of STP that allows a physical port to belong to multiple STPDs by assigning the port to multiple VLANs. EMISTP adds significant flexibility to STP network design. BPDUs are sent with an 802.1Q tag having an STPD instance Identifier (STPD ID) in the VLAN ID field.

This encapsulation mode supports the following STPD modes of operation: 802.1D and 802.1w.
- Per VLAN Spanning Tree (PVST+) mode

This mode implements PVST+ in compatibility with third-party switches running this version of STP. The STPDs running in this mode have a one-to-one relationship with VLANs and send and process packets in PVST+ format.

This encapsulation mode supports the following STPD modes of operation: 802.1D and 802.1w.

These encapsulation modes are for STP ports, not for physical ports. When a physical port belongs to multiple STPDs, it is associated with multiple STP ports. It is possible for the physical port to run in different modes for different domains to which it belongs.

If configured in MSTP mode, an STPD uses the 802.1D BPDU encapsulation mode by default. To ensure correct operation of your MSTP STPDs, do not configure EMISTP or PVST+ encapsulation mode for MSTP STPDs.

To configure the BPDU encapsulation mode for one or more STP ports, use the following command:

```
configure stpd <stpd_name> ports mode [dot1d | emistp | pvst-plus] <port_list>
```

To configure the default BPDU encapsulation mode on a per STPD basis, use the following command:

```
configure stpd <stpd_name> default-encapsulation [dot1d | emistp | pvst-plus]
```

Instead of accepting the default encapsulation modes of `dot1d` for the default STPD `s0` and `emistp` for all other STPDs, this command allows you to specify the type of BPDU encapsulation to use for all ports added to the STPD (if not otherwise specified).

STPD Identifier

An StpdID is used to identify each STP domain. You assign the StpdID when configuring the domain, and that carrier VLAN of that STPD cannot belong to another STPD. Unless all ports are running in 802.1D mode, an STPD with ports running in either EMISTP mode or PVST+ mode must be configured with an StpdID.

An StpdID must be identical to the VLAN ID of the carrier VLAN in that STP domain. For an 802.1D STPD, the VLAN ID can be either a user-defined ID or one automatically assigned by the switch.



NOTE

If an STPD contains at least one port not in 802.1D mode, you must configure the STPD with an StpdID.

MSTP uses two different methods to identify the STPDs that are part of the MSTP network. An instance ID of 0 identifies the CIST. The switch assigns this ID automatically when you configure the CIST STPD. An MSTI identifier (MSTI ID) identifies each STP domain that is part of an MSTP region. You assign the MSTI ID when configuring the STPD that participates in the MSTP region. In an MSTP region, MSTI IDs only have local significance. You can reuse MSTI IDs across MSTP regions. For more information about MSTP and MSTP features, see [“Multiple Spanning Tree Protocol” on page 1042](#).

STP States

Each port that belongs to a member VLAN participating in STP exists in one of the following states:

- **Blocking**
A port in the blocking state does not accept ingress traffic, perform traffic forwarding, or learn MAC source addresses. The port receives STP BPDUs. During STP initialization, the switch always enters the blocking state.
- **Listening**
A port in the listening state does not accept ingress traffic, perform traffic forwarding, or learn MAC source addresses. The port receives STP BPDUs. This is the first transitional state a port enters after

being in the blocking state. The bridge listens for BPDUs from neighboring bridge(s) to determine whether the port should or should not be blocked.

- Learning

A port in the learning state does not accept ingress traffic or perform traffic forwarding, but it begins to learn MAC source addresses. The port also receives and processes STP BPDUs. This is the second transitional state after listening. From learning, the port will change to either blocking or forwarding.

- Forwarding

A port in the forwarding state accepts ingress traffic, learns new MAC source addresses, forwards traffic, and receives and processes STP BPDUs.

- Disabled

A port in the disabled state does not participate in STP; however, it will forward traffic and learn new MAC source addresses.

Binding Ports

The two ways to bind (add) ports to an STPD are: manually and automatically. By default, ports are manually added to an STPD.



NOTE

The default VLAN and STPD S0 are already on the switch.

Manually Binding Ports

To manually bind ports, use one of the following commands:

- `configure stpd <stpd_name> add vlan <vlan_name> ports [all | <port_list>] {[dot1d | emistp | pvst-plus]}`
- `configure vlan <vlan_name> add ports [all | <port_list>] {tagged | untagged} stpd <stpd_name> {[dot1d | emistp | pvst-plus]}`

The first command adds all ports or a list of ports within the specified VLAN to an STPD. For EMISTP and PVST+, the carrier VLAN must already exist on the same set of ports. The second command adds all ports or a list of ports to the specified VLAN and STPD at the same time. If the ports are added to the VLAN but not to the STPD, the ports remain in the VLAN.

For EMISTP and PVST+, if the specified VLAN is not the carrier VLAN and the specified ports are not bound to the carrier VLAN, the system displays an error message. If you configure MSTP on your switch, MSTP does not need carrier VLANs.



NOTE

The carrier VLAN's ID must be identical to the ID of the STP domain.

If you add a protected VLAN or port, that addition inherits the carrier VLAN's encapsulation mode unless you specify the encapsulation mode when you execute the `configure stpd add vlan` or `configure vlan add ports stpd` commands. If you specify an encapsulation mode (dot1d, emistp,

or `pvst-plus`), the STP port mode is changed to match; otherwise, the STP port inherits either the carrier VLANs encapsulation mode on that port or the STPD's default encapsulation mode.

For MSTP, you do not need carrier a VLAN. A CIST controls the connectivity of interconnecting MSTP regions and sends BPDUs across the regions to communicate region status. You must use the `dot1d` encapsulation mode in an MSTP environment. For more information about MSTP, see the section [“Multiple Spanning Tree Protocol” on page 1042](#).

To remove ports, use the following command:

```
configure stpd <stpd_name> delete vlan <vlan_name> ports [all | <port_list>]
```

If you manually delete a protected VLAN or port, only that VLAN or port is removed. If you manually delete a carrier VLAN or port, all VLANs on that port (both carrier and protected) are deleted from that STPD.

To learn more about member VLANs, see [“Member VLANs” on page 1015](#). For more detailed information about these command line interface (CLI) commands, see the *ExtremeXOS Command Reference Guide*.

Automatically Binding Ports

To automatically bind ports to an STPD when the ports are added to a VLAN, use the following command:

```
enable stpd <stpd_name> auto-bind vlan <vlan_name>
```

The autobind feature is disabled on user-created STPDs. The autobind feature is enabled on the default VLAN that participates in the default STPD S0.

For EMISTP or PVST+, when you issue this command, any port or list of ports that you add to the carrier VLAN are automatically added to the STPD with autobind enabled. In addition, any port or list of ports that you remove from a carrier VLAN are automatically removed from the STPD. This feature allows the STPD to increase or decrease its span as ports are added to or removed from a carrier VLAN.



NOTE

The carrier VLAN's ID must be identical to the ID of the STP domain.

Enabling autobind on a protected VLAN does not expand the boundary of the STPD. If the same set of ports are members of the protected VLAN and the carrier VLAN, protected VLANs are aware of STP state changes. For example, assume you have the following scenario:

- Carrier VLAN named *v1*
- *v1* contains ports 3:1-3:2
- Protected VLAN named *v2*
- *v2* contains ports 3:1-3:4

Since *v1* contains ports 3:1-3:2, *v2* is aware only of the STP changes for ports 3:1 and 3:2, respectively. Ports 3:3 and 3:4 are not part of the STPD, which is why *v2* is not aware of any STP changes for those ports.

In addition, enabling autobind on a protected VLAN causes ports to be automatically added or removed as the carrier VLAN changes.

For MSTP, when you issue this command, any port or list of ports that gets automatically added to an MSTI are automatically inherited by the CIST. In addition, any port or list of ports that you remove from an MSTI protected VLAN are automatically removed from the CIST. For more information, see [“Automatically Inheriting Ports—MSTP Only.”](#)

To remove ports, use the following command:

```
configure stpd <stpd_name> delete vlan <vlan_name> ports [all | <port_list>]
```

If you manually delete a port from the STPD on a VLAN that has been added by autobind, ExtremeXOS records the deletion so that the port does not get automatically added to the STPD after a system restart.

To learn more about the member VLANs, see [“Member VLANs” on page 1015](#). For more detailed information about these CLI commands, see the *ExtremeXOS Command Reference Guide*.

Automatically Inheriting Ports—MSTP Only

In an MSTP environment, whether you manually or automatically bind a port to an MSTI in an MSTP region, the switch automatically binds that port to the CIST. The CIST handles BPDU processing for itself and all of the MSTIs; therefore, the CIST must inherit ports from the MSTIs in order to transmit and receive BPDUs. You can only delete ports from the CIST if it is no longer a member of an MSTI.

For more information about MSTP, see [“Multiple Spanning Tree Protocol” on page 1042](#).

Rapid Root Failover

ExtremeXOS supports rapid root failover for faster STP failover recovery times in STP 802.1D mode. If the active root port link goes down, ExtremeXOS recalculates STP and elects a new root port. The rapid root failover feature allows the new root port to immediately begin forwarding, skipping the standard listening and learning phases. Rapid root failover occurs only when the link goes down and not when there is any other root port failure, such as missing BPDUs.

The default setting for this feature is disabled. To enable rapid root failover, use the following command:

```
enable stpd <stpd_name> rapid-root-failover
```

To display the configuration, use the following command:

```
show stpd {<stpd_name> | detail}
```

STPD BPDU Tunneling

You can configure ExtremeXOS to allow a BPDU to traverse a VLAN without being processed by STP. This is known as BPDU tunneling. There are differences in how to configure this behavior in ExtremeWare and ExtremeXOS. The examples in this section show how you might have used this feature in ExtremeWare and how to configure STPD BPDU tunneling with ExtremeXOS.

You may be more familiar configuring STPD BPDU tunneling on Extreme Networks devices running ExtremeWare. In ExtremeWare, you specify the VLAN to add to the STPD and then you “ignore” the STP BPDUs. By ignoring the STP BPDUs, the switch prevents the ports in the VLAN from becoming part of the STPD. In ExtremeXOS, you specify the VLAN to add to the STPD and then you disable that

STPD. By disabling the STPD, the switch allows the ports associated with the VLAN to continue passing traffic and the switch forwards the BPDUs without adding any STP information.

Figure 137: Sample Network Using STPD BPDU Tunneling



EX_180

The examples described below assume you have already done the following:

- Created the VLANs v1, v2, and v3
- Configured the VLAN tags
- Created the STPDs s1, s2, and s3
- Configured the STPD tags
- Configured the mode of operation for the STPD
- Configured the STP ports
- Enabled STPD

The following example shows how to configure STPD BPDU tunneling on devices running ExtremeWare:

Switch A

```
enable ignore-bpdu vlan v1
enable ignore-bpdu vlan v2
enable ignore-bpdu vlan v3
configure vlan v1 add ports 1:1,2:1 tagged stpd s1
configure vlan v2 add ports 1:2,2:1 tagged stpd s2
configure vlan v3 add ports 1:3,2:1 tagged stpd s3
```

Switch B

```
enable ignore-bpdu vlan v1
enable ignore-bpdu vlan v2
configure vlan v1 add ports 1:1,2:1 tagged stpd s1
configure vlan v2 add ports 1:2,2:1 tagged stpd s2
```

Switch C

```
enable ignore-bpdu vlan v1
enable ignore-bpdu vlan v3
configure vlan v1 add ports 1:1,2:1 tagged stpd s1
configure vlan v3 add ports 1:3,2:1 tagged stpd s3
```

The following example shows how to configure STPD BPDU tunneling on devices running ExtremeXOS:

Switch A

```
configure vlan v1 add ports 1:1,2:1 tagged
configure vlan v2 add ports 1:2,2:1 tagged
configure vlan v3 add ports 1:3,2:1 tagged
configure stpd s1 add vlan v1 ports 1:1
configure stpd s2 add vlan v2 ports 1:2
configure stpd s3 add vlan v3 ports 1:3
disable s1
disable s2
disable s3
```

Switch B

```
configure vlan v1 add ports 1:1,2:1 tagged
configure vlan v2 add ports 1:2,2:1 tagged
configure stpd s1 add vlan v1 ports 1:1
configure stpd s2 add vlan v2 ports 1:2
disable s1
disable s2
```

Switch C

```
configure vlan v1 add ports 1:1,2:1 tagged
configure vlan v3 add ports 1:3,2:1 tagged
configure stpd s1 add vlan v1 ports 1:1
configure stpd s3 add vlan v3 ports 1:3
disable s1
disable s3
```

STP and Hitless Failover—Modular Switches Only

When you install two management modules (MSM/MM) in a BlackDiamond chassis or you are using redundancy in a SummitStack, one node assumes the role of primary and the other node assumes the role of backup. The primary executes the switch's management functions, and the backup acts in a standby role. Hitless failover transfers switch management control from the primary to the backup and maintains the state of STP. STP supports hitless failover. You do not explicitly configure hitless failover support; rather, if you have two nodes installed, hitless failover is available.

**NOTE**

Not all platforms support hitless failover in the same software release. To verify if the software version you are running supports hitless failover, see [Table 15 in Chapter 2, “Managing the Switch.”](#) For more information about protocol, platform, and MSM/MM support for hitless failover, see [“Understanding Hitless Failover Support—Modular Switches and SummitStack Only” in Chapter 2, “Managing the Switch.”](#)

To support hitless failover, the primary node replicates STP BPDUs to the backup, which allows the nodes to run STP in parallel. Although both primary and backup node receive STP BPDUs, only the primary transmits STP BPDUs to neighboring switches and participates in STP.

**NOTE**

Before initiating failover, review the section [“Synchronizing Nodes—Modular Switches and SummitStack Only” on page 1500](#) to confirm that both primary and backup nodes are running software that supports the `synchronize` command.

To initiate hitless failover on a network that uses STP:

- 1 Confirm that the nodes are synchronized and have identical software and switch configurations using the `show switch {detail}` command. The output displays the status of the primary and backup nodes, with the primary node showing `MASTER` and the backup node showing `BACKUP (InSync)`.
 - If the primary and backup nodes are not synchronized and both nodes are running a version of ExtremeXOS that supports synchronization, proceed to step 2.
 - If the primary and backup nodes are synchronized, proceed to step 3.
- 2 If the primary and backup nodes are not synchronized, use the `synchronize` command to replicate all saved images and configurations from the primary to the backup. After you confirm the nodes are synchronized, proceed to step 3.
- 3 If the nodes are synchronized, use the `run failover` (formerly `run msm-failover`) command to initiate failover.

For more detailed information about verifying the status of the primary and backup nodes, and system redundancy, see [“Understanding System Redundancy—Modular Switches and SummitStack Only” on page 81](#). For more information about hitless failover, see [“Understanding Hitless Failover Support—Modular Switches and SummitStack Only” on page 85](#).

STP Configurations

When you assign VLANs to an STPD, pay careful attention to the STP configuration and its effect on the forwarding of VLAN traffic.

This section describes three types of STP configurations:

- Basic STP
- Multiple STPDs on a single port (which uses EMISTP)
- A VLAN that spans multiple STPDs

Basic STP Configuration

This section describes a basic, 802.1D STP configuration. [Figure 138](#) illustrates a network that uses VLAN tagging for trunk connections. The following four VLANs have been defined:

- *Sales* is defined on switch A, switch B, and switch M.
- *Personnel* is defined on switch A, switch B, and switch M.
- *Manufacturing* is defined on switch Y, switch Z, and switch M.
- *Engineering* is defined on switch Y, switch Z, and switch M.
- *Marketing* is defined on all switches (switch A, switch B, switch Y, switch Z, and switch M).

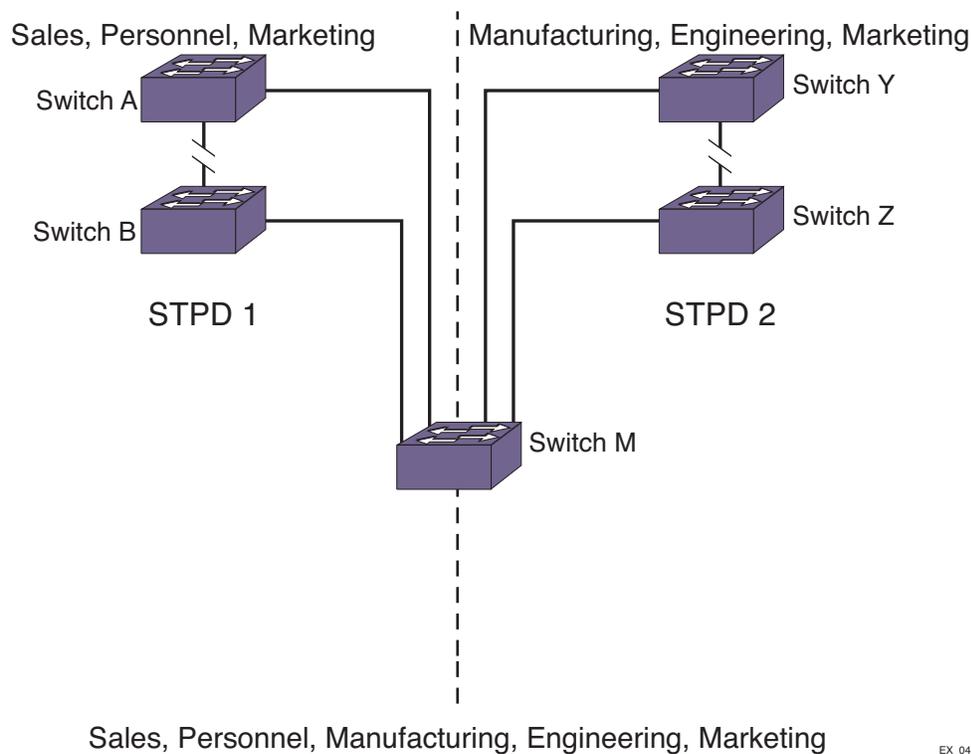
Two STPDs are defined:

- STPD1 contains VLANs *Sales* and *Personnel*.
- STPD2 contains VLANs *Manufacturing* and *Engineering*.

The carrier and protected VLANs are also defined:

- *Sales* is the carrier VLAN on *STPD1*.
- *Personnel* is a protected VLAN on *STPD1*.
- *Manufacturing* is a protected VLAN on *STPD2*.
- *Engineering* is the carrier VLAN on *STPD2*.
- *Marketing* is a member of both *STPD1* and *STPD2* and is a protected VLAN.

Figure 138: Multiple STPDs



EX_048

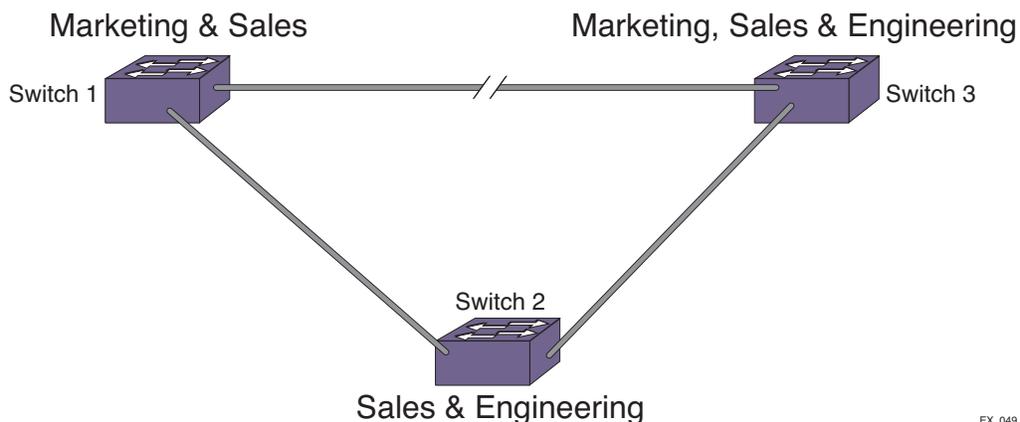
When the switches in this configuration boot-up, STP configures each STPD such that the topology contains no active loops. STP could configure the topology in a number of ways to make it loop-free.

In [Figure 138](#), the connection between switch A and switch B is put into blocking state, and the connection between switch Y and switch Z is put into blocking state. After STP converges, all the VLANs can communicate, and all bridging loops are prevented.

The protected VLAN *Marketing*, which has been assigned to both STPD1 and STPD2, communicates using all five switches. The topology has no loops, because STP has already blocked the port connection between switch A and switch B and between switch Y and switch Z.

Within a single STPD, you must be extra careful when configuring your VLANs. [Figure 139](#) illustrates a network that has been incorrectly set up using a single STPD so that the STP configuration disables the ability of the switches to forward VLAN traffic.

Figure 139: Incorrect Tag-Based STPD Configuration



The tag-based network in [Figure 139](#) has the following configuration:

- Switch 1 contains VLAN *Marketing* and VLAN *Sales*.
- Switch 2 contains VLAN *Engineering* and VLAN *Sales*.
- Switch 3 contains VLAN *Marketing*, VLAN *Engineering*, and VLAN *Sales*.
- The tagged trunk connections for three switches form a triangular loop that is not permitted in an STP topology.
- All VLANs in each switch are members of the same STPD.

STP can block traffic between switch 1 and switch 3 by disabling the trunk ports for that connection on each switch.

Switch 2 has no ports assigned to VLAN *Marketing*. Therefore, if the trunk for VLAN *Marketing* on switches 1 and 3 is blocked, the traffic for VLAN *Marketing* will not be able to traverse the switches.



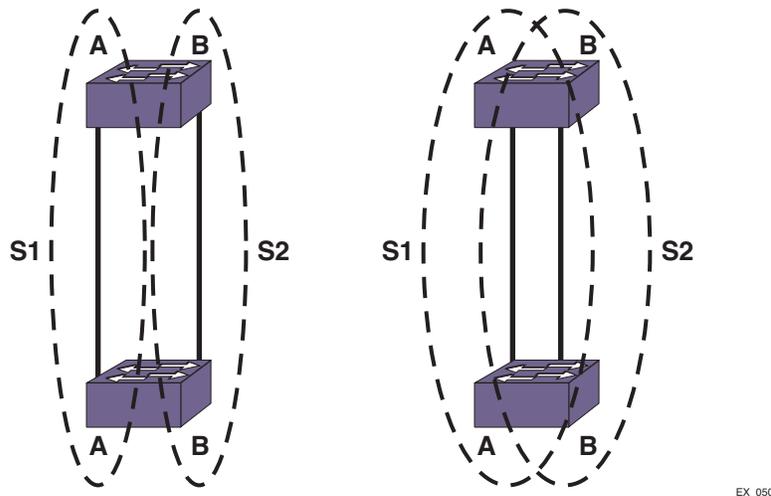
NOTE

If an STPD contains multiple VLANs, all VLANs should be configured on all ports in that domain, except for ports that connect to hosts (edge ports).

Multiple STPDs on a Port

Traditional 802.1D STP has some inherent limitations when addressing networks that have multiple VLANs and multiple STPDs. For example, consider the sample depicted in [Figure 140](#).

Figure 140: Limitations of Traditional STPD



The two switches are connected by a pair of parallel links. Both switches run two VLANs, A and B. To achieve load-balancing between the two links using the traditional approach, you would have to associate A and B with two different STPDs, called S1 and S2, respectively, and make the left link carry VLAN A traffic while the right link carries VLAN B traffic (or vice versa). If the right link fails, S2 is broken and VLAN B traffic is disrupted.

To optimize the solution, you can use the Extreme Multiple Instance Spanning (EMISTP) mode, which allows a port to belong to multiple STPDs. EMISTP adds significant flexibility to STP network design. Referring to [Figure 140](#), using EMISTP, you can configure all four ports to belong to both VLANs.

Assuming that S1 and S2 still correspond to VLANs A and B, respectively, you can fine-tune STP parameters to make the left link active in S1 and blocking in S2, while the right link is active in S2 and blocking in S1. Again, if the right link fails, the left link is elected active by the STP algorithm for S2, without affecting normal switching of data traffic.

Using EMISTP, an STPD becomes more of an abstract concept. The STPD does not necessarily correspond to a physical domain; it is better regarded as a vehicle to carry VLANs that have STP instances. Because VLANs can overlap, so do STPDs. However, even if the different STPDs share the entire topology or part of the redundant topology, the STPDs react to topology change events in an independent fashion.

VLANs Spanning Multiple STPDs

Traditionally, the mapping from VLANs to STP instances have been one-to-one or many-to-one. In both cases, a VLAN is wholly contained in a single instance. In practical deployment there are cases in which a one-to-many mapping is desirable. In a typical large enterprise network, for example, VLANs span multiple sites and/or buildings. Each site represents a redundant looped area. However, between any two sites the topology is usually very simple.

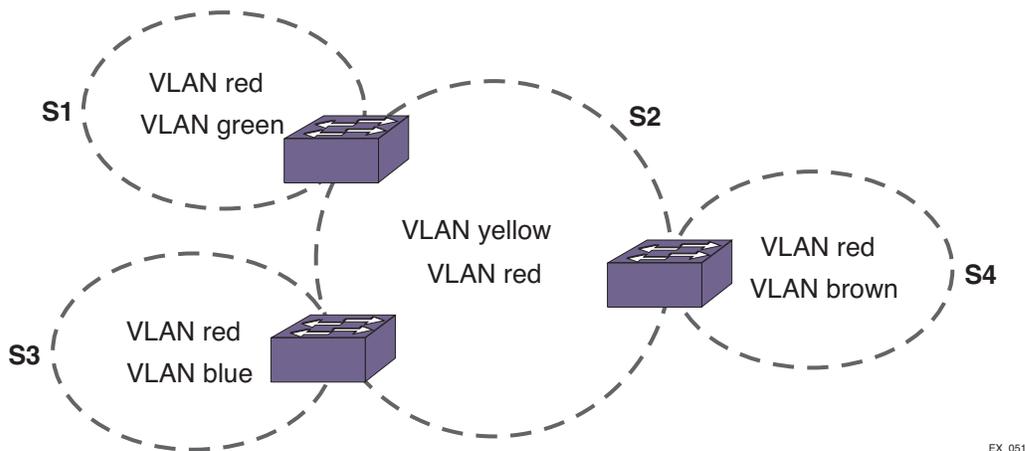
Alternatively, the same VLAN may span multiple large geographical areas (because they belong to the same enterprise) and may traverse a great many nodes. In this case, it is desirable to have multiple STP domains operating in a single VLAN, one for each looped area.

The justifications include the following:

- The complexity of the STP algorithm increases, and performance drops, with the size and complexity of the network. The 802.1D standard specifies a maximum network diameter of seven hops. By segregating a big VLAN into multiple STPDs, you reduce complexity and enhance performance.
- Local to each site, there may be other smaller VLANs that share the same redundant looped area with the large VLAN. Some STPDs must be created to protect those VLANs. The ability to partition VLANs allows the large VLAN to be “piggybacked” in those STPDs in a site-specific fashion.

Figure 141 has five domains. VLANs green, blue, brown, and yellow are local to each domain. VLAN red spans all of the four domains. Using a VLAN that spans multiple STPDs, you do not have to create a separate domain for VLAN red. Instead, VLAN red is “piggybacked” onto those domains local to other VLANs.

Figure 141: VLANs Spanning Multiple STPDs



In addition, the configuration in Figure 141 has these features:

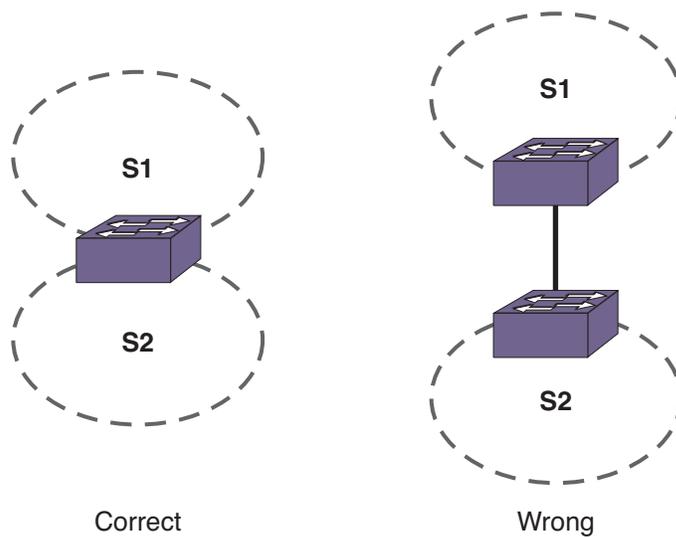
- Each site can be administered by a different organization or department within the enterprise. Having a site-specific STP implementation makes the administration more flexible and convenient.
- Between the sites the connections usually traverse distribution switches in ways that are known beforehand to be “safe” with STP. In other words, the looped areas are already well-defined.

EMISTP Deployment Constraints

Although EMISTP greatly enhances STP capability, these features must be deployed with care. This section describes configuration issues that, if not followed, could lead to an improper deployment of EMISTP. This section also provides the following restrictive principles to abide by in network design:

- Although a physical port can belong to multiple STPDs, any VLAN on that port can be in only *one* domain. Put another way, a VLAN cannot belong to two STPDs on the same physical port.
- Although a VLAN can span multiple domains, any LAN segment in that VLAN must be in the same STPD. VLANs traverse STPDs only inside switches, not across links. On a single switch, however, bridge ports for the same VLAN can be assigned to different STPDs. This scenario is illustrated in Figure 142.

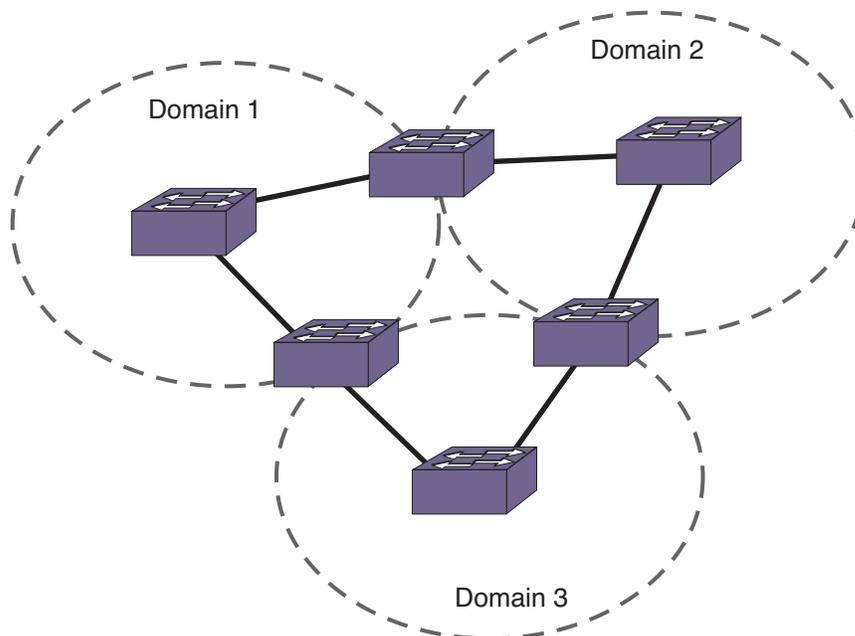
Figure 142: VLANs Traverse Domains Inside Switches



EX_052

- The VLAN partition feature is deployed under the premise that the overall inter-domain topology for that VLAN is loop-free. Consider the case in Figure 143, VLAN red (the only VLAN in the figure) spans STPDs 1, 2, and 3. Inside each domain, STP produces a loop-free topology. However, VLAN red is still looped, because the three domains form a ring among themselves.

Figure 143: Looped VLAN Topology



EX_053

- A necessary (but not sufficient) condition for a loop-free inter-domain topology is that every two domains only meet at a single crossing point.

**NOTE**

You can use MSTP to overcome the EMISTP constraints described in this section. See [“Multiple Spanning Tree Protocol” on page 1042](#) for information about MSTP.

Per VLAN Spanning Tree

Switching products that implement Per VLAN Spanning Tree (PVST) have been in existence for many years and are widely deployed. To support STP configurations that use PVST, ExtremeXOS has an operational mode called PVST+.

**NOTE**

In this document, PVST and PVST+ are used interchangeably. PVST+ is an enhanced version of PVST that is interoperable with 802.1Q STP. The following discussions are in regard to PVST+, if not specifically mentioned.

STPD VLAN Mapping

Each VLAN participating in PVST+ must be in a separate STPD, and the VLAN number (VLAN ID) must be the same as the STPD identifier (STPD ID). As a result, PVST+ protected VLANs cannot be partitioned.

This fact does not exclude other non-PVST+ protected VLANs from being grouped into the same STPD. A protected PVST+ VLAN can be joined by multiple non-PVST+ protected VLANs to be in the same STPD.

Native VLAN

In PVST+, the native VLAN must be peered with the default VLAN on Extreme Networks devices, as both are the only VLAN allowed to send and receive untagged packets on the physical port.

Third-party PVST+ devices send VLAN 1 packets in a special manner. ExtremeXOS does not support PVST+ for VLAN 1. Therefore, when the switch receives a packet for VLAN 1, the packet is dropped.

When a PVST+ instance is disabled, the fact that PVST+ uses a different packet format raises an issue. If the STPD also contains ports not in PVST+ mode, the flooded packet has an incompatible format with those ports. The packet is not recognized by the devices connected to those ports.

Rapid Spanning Tree Protocol

The Rapid Spanning Tree Protocol (RSTP), originally in the IEEE 802.1w standard and now part of the IEEE 802.1D-2004 standard, provides an enhanced spanning tree algorithm that improves the convergence speed of bridged networks. RSTP takes advantage of point-to-point links in the network and actively confirms that a port can safely transition to the forwarding state without relying on any timer configurations. If a network topology change or failure occurs, RSTP rapidly recovers network

connectivity by confirming the change locally before propagating that change to other devices across the network. For broadcast links, there is no difference in convergence time between STP and RSTP.

RSTP supersedes legacy STP protocols, supports the existing STP parameters and configurations, and allows for seamless interoperability with legacy STP.

RSTP Concepts

This section describes the following important RSTP concepts:

- [Port Roles on page 1031](#)
- [Link Types on page 1032](#)
- [RSTP Timers on page 1034](#)

Port Roles

RSTP uses information from BPDUs to assign port roles for each LAN segment. Port roles are not user-configurable. Port role assignments are determined based on the following criteria:

- A unique bridge identifier (MAC address) associated with each bridge
- The path cost associated with each bridge port
- A port identifier associated with each bridge port

RSTP assigns one of the following port roles to bridge ports in the network, as described in [Table 106](#).

Table 106: RSTP Port Roles

Port Role	Description
Root	Provides the shortest (lowest) path cost to the root bridge. Each bridge has only one root port; the root bridge does not have a root port. If a bridge has two or more ports with the same path cost, the port with the best port identifier (lowest MAC address) becomes the root port.
Designated	Provides the shortest path connection to the root bridge for the attached LAN segment. To prevent loops in the network, there is only one designated port on each LAN segment. To select the designated port, all bridges that are connected to a particular segment listen to each other's BPDUs and agree on the bridge sending the best BPDU. The corresponding port on that bridge becomes the designated port. If there are two or more ports connected to the LAN, the port with the best port identifier becomes the designated port.
Alternate	Provides an alternate path to the root bridge and the root port.
Backup	Supports the designated port on the same attached LAN segment. Backup ports exist only when the bridge is connected as a self-loop or to a shared-media segment.
Disabled	A port in the disabled state does not participate in RSTP; however, it will forward traffic and learn new MAC source addresses.

When RSTP stabilizes, all:

- Root ports and designated ports are in the forwarding state.
- Alternate ports and backup ports are in the blocking state.

RSTP makes the distinction between the alternate and backup port roles to describe the rapid transition of the alternate port to the forwarding state if the root port fails.

To prevent a port from becoming an alternate or backup port, use the following command:

```
configure stpd <stpd_name> ports active-role enable <port>
```

To revert to the default that allows a port to be elected to any STP port role, use the following command:

```
configure stpd <stpd_name> ports active-role disable <port>
```

To view the active-role status, use the following command:

```
show stpd ports
```

Link Types

With RSTP, you can configure the link type of a port in an STPD. RSTP tries to rapidly move designated point-to-point links into the forwarding state when a network topology change or failure occurs. For rapid convergence to occur, the port must be configured as a point-to-point link.

Table 107 describes the link types.

Table 107: RSTP Link Types

Port Link Type	Description
Auto	Specifies the switch to automatically determine the port link type. An auto link behaves like a point-to-point link if the link is in full-duplex mode or if link aggregation is enabled on the port. Otherwise, the link behaves like a broadcast link used for 802.1w configurations.
Edge	Specifies a port that does not have a bridge attached. An edge port is held in the STP forwarding state unless a BPDU is received by the port. In that case, the port behaves as a normal RSTP port. The port is no longer considered an edge port. If the port does not receive subsequent BPDUs during a pre-determined time, the port attempts to become an edge port. ExtremeXOS 11.5 or earlier—An edge port is placed and held in the STP forwarding state unless a BPDU is received by the port. In that case, an edge port enters and remains in the blocking state until it stops receiving BPDUs and the message age timer expires.
Broadcast	Specifies a port attached to a LAN segment with more than two bridges. A port with a broadcast link type cannot participate in rapid reconfiguration using RSTP or MSTP. By default, all ports are broadcast links.
Point-to-point	Specifies a port attached to a LAN segment with only two bridges. A port with point-to-point link type can participate in rapid reconfiguration. Used for 802.1w and MSTP configurations.

Configuring Link Types. By default, all ports are broadcast links. To configure the ports in an STPD, use the following command:

```
configure stpd <stpd_name> ports link-type [[auto | broadcast | point-to-point]
<port_list> | edge <port_list> {edge-safeguard [enable | disable] {bpdu-restrict}
{recovery-timeout <seconds>}}]
```

Where the following is true:

- `auto`—Configures the ports as auto links. If the link is in full-duplex mode or if link aggregation is enabled on the port, an auto link behaves like a point-to-point link.
- `broadcast`—Configures the ports as broadcast ports. By default, all ports are broadcast links.
- `point-to-point`—Configures the ports for rapid reconfiguration in an RSTP or MSTP environment.
- `edge`—Configures the ports as edge ports. For information about edge safeguard, see “[Configuring Edge Safeguard](#)” next.

To change the existing configuration of a port in an STPD, and return the port to factory defaults, use the following command:

```
unconfigure stpd <stpd_name> ports link-type <port_list>
```

To display detailed information about the ports in an STPD, use the following command:

```
show {stpd} <stpd_name> ports [[detail | <port_list> {detail}]]
```

Configuring Edge Safeguard. Loop prevention and detection on an edge port configured for RSTP is called “edge safeguard.” You configure edge safeguard on RSTP edge ports to prevent accidental or deliberate misconfigurations (loops) resulting from connecting two edge ports together or by connecting a hub or other non-STP switch to an edge port. Edge safeguard also limits the impact of broadcast storms that might occur on edge ports. This advanced loop prevention mechanism improves network resiliency but does not interfere with the rapid convergence of edge ports.

An edge port configured with edge safeguard immediately enters the forwarding state and transmits BPDUs. If a loop is detected, STP blocks the port. By default, an edge port without edge safeguard configured immediately enters the forwarding state but does not transmit BPDUs unless a BPDU is received by that edge port.

You can also configure edge safeguard for loop prevention and detection on an MSTP edge port.

To configure an edge port and enable edge safeguard on that port, use the following command:

```
configure stpd <stpd_name> ports link-type [[auto | broadcast | point-to-point]
<port_list> | edge <port_list> {edge-safeguard [enable | disable] {bpdu-restrict}
{recovery-timeout <seconds>}}]
```

If you have already configured a port as an edge port and you want to enable edge safeguard on the port, use the following command:

```
configure {stpd} <stpd_name> ports edge-safeguard enable <port_list> {bpdu-restrict}
{recovery-timeout {<seconds>}}
```

To disable edge safeguard on an edge port, use one of the following commands:

- `configure {stpd} <stpd_name> ports edge-safeguard disable <port_list> {bpdu-restrict} {recovery-timeout {<seconds>}}`
- `configure stpd <stpd_name> ports link-type [[auto | broadcast | point-to-point] <port_list> | edge <port_list> {edge-safeguard [enable | disable] {bpdu-restrict} {recovery-timeout <seconds>}}]`

In ExtremeXOS 11.5 and earlier, ports that connect to non-STP devices are edge ports. Edge ports do not participate in RSTP, and their role is not confirmed. Edge ports immediately enter the forwarding state unless the port receives a BPDU. In that case, edge ports enter the blocking state. The edge port remains in the blocking state until it stops receiving BPDUs and the message age timer expires.

ExtremeXOS 11.6 and later support an enhanced bridge detection method, which is part of the 802.1D-2004 standard. Ports that connect to non-STP devices are still considered edge ports. However, if you have an 802.1D-2004 compliant edge port, the bridge detection mechanism causes the edge port to transition to a non-edge port upon receiving a BPDU. If the former edge port does not receive a subsequent BPDU during a pre-determined interval, the port attempts to become an edge port.

In ExtremeXOS 12.0.3 and 12.1.4 onwards, STP edge safeguard disables a port when a remote loop is detected. ExtremeXOS versions prior to 12.0.3 and 12.1.4 place the port in blocking mode. The change was made because BPDUs are still processed when a port is in a blocking state. A remote loop causes BPDUs to be exponentially duplicated which caused high CPU utilization on the switch even though the port was transitioned to a blocked state.

RSTP Timers

For RSTP to rapidly recover network connectivity, RSTP requires timer expiration. RSTP derives many of the timer values from the existing configured STP timers to meet its rapid recovery requirements rather than relying on additional timer configurations. [Table 108](#) describes the user-configurable timers, and [Table 109](#) describes the timers that are derived from other timers and not user-configurable.

Table 108: User-Configurable Timers

Timer	Description
Hello	The root bridge uses the hello timer to send out configuration BPDUs through all of its forwarding ports at a predetermined, regular time interval. The default value is 2 seconds. The range is 1 to 10 seconds.
Forward delay	A port moving from the blocking state to the forwarding state uses the forward delay timer to transition through the listening and learning states. In RSTP, this timer complements the rapid configuration behavior. If none of the rapid rules are in effect, the port uses legacy STP rules to move to the forwarding state. The default is 15 seconds. The range is 4 to 30 seconds.

Table 109: Derived Timers

Timer	Description
TCN	The root port uses the topology change notification (TCN) timer when it detects a change in the network topology. The TCN timer stops when the topology change timer expires or upon receipt of a topology change acknowledgement. The default value is the same as the value for the bridge hello timer.
Topology change	The topology change timer determines the total time it takes the forwarding ports to send configuration BPDUs. The default value for the topology change timer depends upon the mode of the port: <ul style="list-style-type: none"> 802.1D mode—The sum of the forward delay timer value (default value is 15 seconds; range of 4 to 30 seconds) and the maximum age timer value (default value is 20 seconds; range of 6 to 40 seconds). 802.1w mode—Double the hello timer value (default value is 4 seconds).
Message age	A port uses the message age timer to time out receiving BPDUs. When a port receives a superior or equal BPDU, the timer restarts. When the timer expires, the port becomes a designated port and a configuration update occurs. If the bridge operates in 1w mode and receives an inferior BPDU, the timer expires early. The default value is the same as the STPD bridge max age parameter.
Hold	A port uses the hold timer to restrict the rate that successive BPDUs can be sent. The default value is the same as the value for the bridge hello timer.
Recent backup	The timer starts when a port leaves the backup role. When this timer is running, the port cannot become a root port. The default value is double the hello time (4 seconds).
Recent root	The timer starts when a port leaves the root port role. When this timer is running, another port cannot become a root port unless the associated port is put into the blocking state. The default value is the same as the forward delay time.

The protocol migration timer is neither user-configurable nor derived; it has a set value of 3 seconds. The timer starts when a port transitions from STP (802.1D) mode to RSTP (802.1w) mode and vice-versa. This timer must expire before further mode transitions can occur.

RSTP Operation

In an RSTP environment, a point-to-point link LAN segment has two bridges. A switch that considers itself the unique, designated bridge for the attached LAN segment sends a “propose” message to the other bridge to request a confirmation of its role. The other bridge on that LAN segment replies with an “agree” message if it agrees with the proposal. The receiving bridge immediately moves its designated port into the forwarding state.

Before a bridge replies with an “agree” message, it reverts all of its designated ports into the blocking state. This introduces a temporary partition into the network. The bridge then sends another “propose” message on all of its designated ports for further confirmation. Because all of the connections are blocked, the bridge immediately sends an “agree” message to unblock the proposing port without having to wait for further confirmations to come back or without the worry of temporary loops.

Beginning with the root bridge, each bridge in the network engages in the exchange of “propose” and “agree” messages until they reach the edge ports. Edge ports connect to non-STP devices and do not participate in RSTP. Their role does not need to be confirmed. If you have an 802.1D-2004 compliant edge port, the bridge detection mechanism causes the edge port to transition to a non-edge port upon receiving a BPDU. If the former edge port does not receive a subsequent BPDU during a pre-determined interval, the port attempts to become an edge port.

RSTP attempts to transition root ports and designated ports to the forwarding state and alternate ports and backup ports to the blocking state as rapidly as possible.

A port transitions to the forwarding state if any of the following is true. The port:

- Has been in either a root or designated port role long enough that the spanning tree information supporting this role assignment has reached all of the bridges in the network.



NOTE

RSTP is backward compatible with STP, so if a port does not move to the forwarding state with any of the RSTP rapid transition rules, a forward delay timer starts and STP behavior takes over.

- Is now a root port and no other ports have a recent role assignment that contradicts with its root port role.
- Is a designated port and attaches to another bridge by a point-to-point link and receives an “agree” message from the other bridge port.
- Is an edge port.

An edge port is a port connected to a non-STP device and is in the forwarding state.

The following sections provide more information about RSTP behavior.

Root Port Rapid Behavior

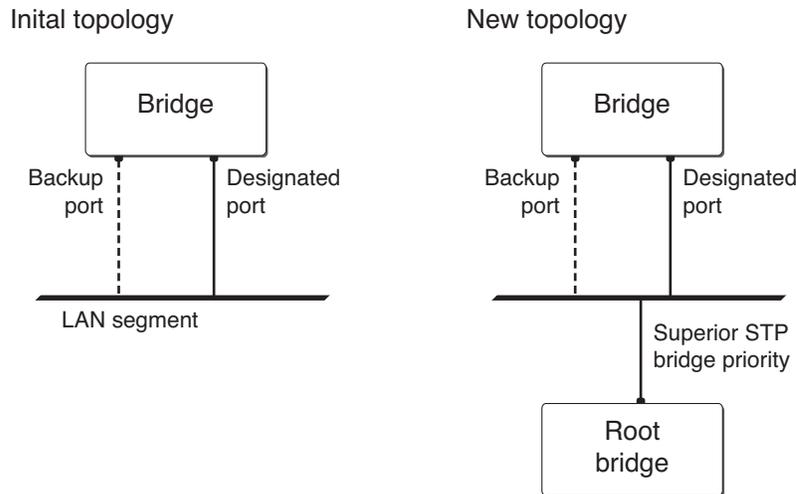
In [Figure 144](#), the diagram on the left displays the initial network topology with a single bridge having the following:

- Two ports are connected to a shared LAN segment.
- One port is the designated port.
- One port is the backup port.

The diagram on the right displays a new bridge that:

- Is connected to the LAN segment
- Has a superior STP bridge priority
- Becomes the root bridge and sends a BPDU to the LAN that is received by both ports on the old bridge

Figure 144: Example of Root Port Rapid Behavior



EX_054

If the backup port receives the BPDU first, STP processes this packet and temporarily elects this port as the new root port while the designated port's role remains unchanged. If the new root port is immediately put into the forwarding state, there is a loop between these two ports.

To prevent this type of loop from occurring, the recent backup timer starts. The root port transition rule does not allow a new root port to be in the forwarding state until the recent backup timer expires.

Another situation may arise if you have more than one bridge and you lower the port cost for the alternate port, which makes it the new root port. The previous root port is now an alternate port. Depending on your STP implementation, STP may set the new root port to the forwarding state before setting the alternate port to the blocking state. This may cause a loop.

To prevent this type of loop from occurring, the recent root timer starts when the port leaves the root port role. The timer stops if the port enters the blocking state. RSTP requires that the recent root timer stop on the previous root port before the new root port can enter the forwarding state.

Designated Port Rapid Behavior

When a port becomes a new designated port, or the STP priority changes on an existing designated port, the port becomes an *unsynced* designated port. For an unsynced designated port to rapidly move into the forwarding state, the port must propose a confirmation of its role on the attached LAN segment (unless the port is an edge port). Upon receiving an "agree" message, the port immediately enters the forwarding state.

If the receiving bridge does not agree and it has a superior STP priority, the receiving bridge replies with its own BPDU. Otherwise, the receiving bridge keeps silent, and the proposing port enters the forwarding state and starts the forward delay timer.

The link between the new designated port and the LAN segment must be a point-to-point link. If there is a multi-access link, the “propose” message is sent to multiple recipients. If only one of the recipients agrees with the proposal, the port can erroneously enter the forwarding state after receiving a single “agree” message.

Receiving Bridge Behavior

The receiving bridge must decide whether or not to accept a proposal from a port. Upon receiving a proposal for a root port, the receiving bridge:

- Processes the BPDU and computes the new STP topology.
- Synchronizes all of the designated ports if the receiving port is the root port of the new topology.
- Puts all unsynced, designated ports into the blocking state.
- Sends down further “propose” messages.
- Sends back an “agree” message through the root port.

If the receiving bridge receives a proposal for a designated port, the bridge replies with its own BPDU. If the proposal is for an alternate or backup port, the bridge keeps silent.

Propagating Topology Change Information

When a change occurs in the topology of the network, such events are communicated through the network.

In an RSTP environment, only non-edge ports entering the forwarding state cause a topology change. A loss of network connectivity is not considered a topology change; however, a gain in network connectivity must be communicated. When an RSTP bridge detects a topology change, that bridge starts the topology change timer, sets the topology change flag on its BPDUs, floods all of the forwarding ports in the network (including the root ports), and flushes the learned MAC address entries.

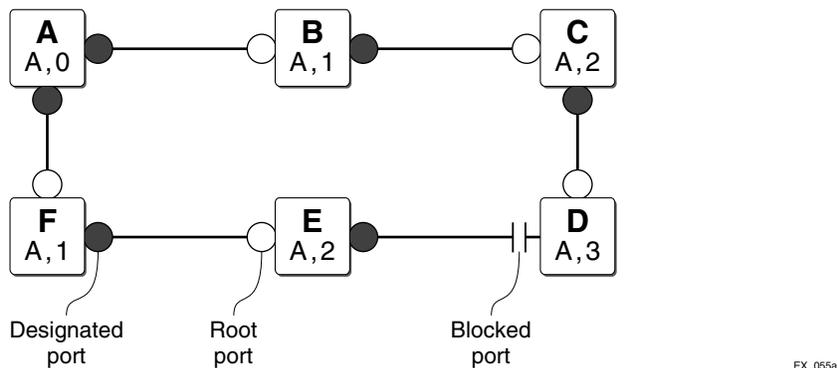
Rapid Reconvergence

This section describes the RSTP rapid behavior following a topology change. In this example, the bridge priorities are assigned based on the order of their alphabetical letters; bridge A has a higher priority than bridge F.

Suppose we have a network, as shown in [Figure 145](#), with six bridges (bridge A through bridge F) where the following is true:

- Bridge A is the root bridge.
- Bridge D contains an alternate port in the blocking state.
- All other ports in the network are in the forwarding state.

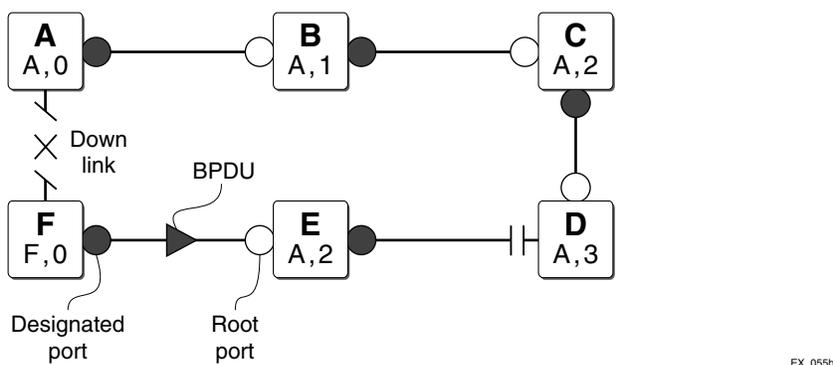
Figure 145: Initial Network Configuration



The network reconverges in the following way:

- 1 If the link between bridge A and bridge F goes down, bridge F detects the root port is down. At this point, bridge F:
 - Immediately disables that port from the STP.
 - Performs a configuration update.
 As shown in [Figure 146](#), after the configuration update, bridge F:
 - Considers itself the new root bridge.
 - Sends a BPDU message on its designated port to bridge E.

Figure 146: Down Link Detected



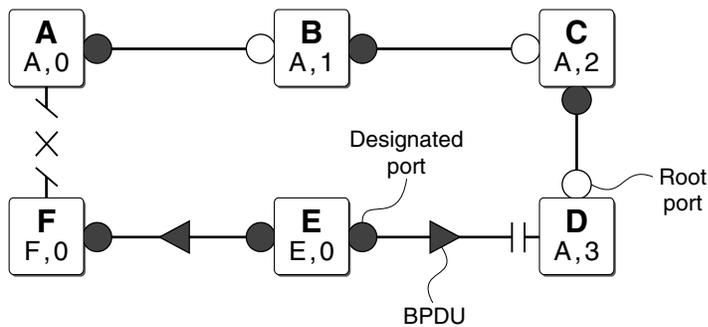
2 Bridge E believes that bridge A is the root bridge. When bridge E receives the BPDU on its root port from bridge F, bridge E:

- Determines that it received an inferior BPDU.
- Immediately begins the max age timer on its root port.
- Performs a configuration update.

As shown in [Figure 147](#), after the configuration update, bridge E:

- Regards itself as the new root bridge.
- Sends BPDU messages on both of its designated ports to bridges F and D, respectively.

Figure 147: New Root Bridge Selected

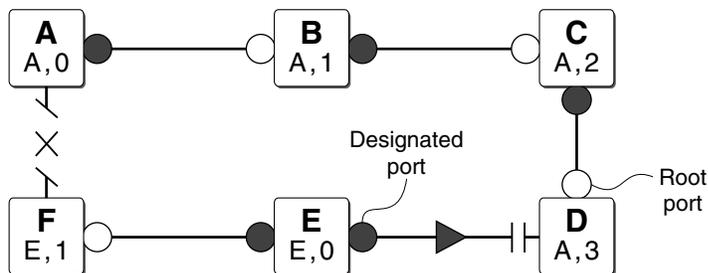


EX_055c

3 As shown in [Figure 148](#), when bridge F receives the superior BPDU and configuration update from bridge E, bridge F:

- Decides that the receiving port is the root port.
- Determines that bridge E is the root bridge.

Figure 148: Communicating New Root Bridge Status to Neighbors



EX_055d

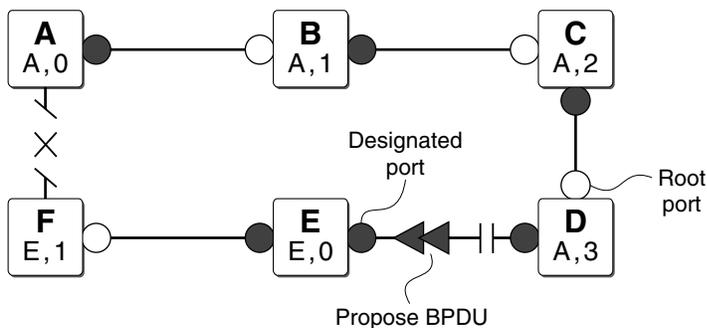
4 Bridge D believes that bridge A is the root bridge. When bridge D receives the BPDU from bridge E on its alternate port, bridge D:

- Immediately begins the max age timer on its alternate port.
- Performs a configuration update.

As shown in [Figure 149](#), after the configuration update, bridge D:

- Moves the alternate port to a designated port.
- Sends a “propose” message to bridge E to solicit confirmation of its designated role and to rapidly move the port into the designated state.

Figure 149: Sending a Propose Message to Confirm a Port Role



EX_055e

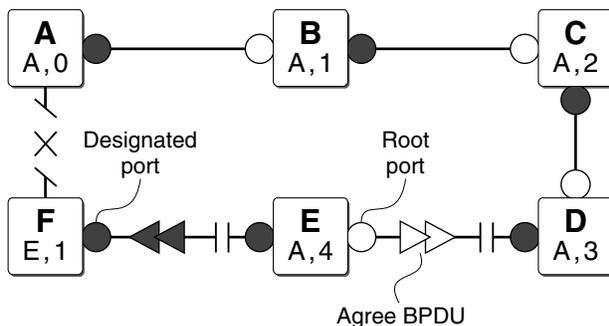
5 Upon receiving the proposal, bridge E (as shown in [Figure 150](#)):

- Performs a configuration update.
 - Changes its receiving port to a root port.
- The existing designated port enters the blocking state.

Bridge E then sends:

- A “propose” message to bridge F.
- An “agree” message from its root port to bridge D.

Figure 150: Communicating Port Status to Neighbors



EX_055f

Multiple Spanning Tree Protocol

The Multiple Spanning Tree Protocol (MSTP), based on IEEE 802.1Q-2003 (formerly known as IEEE 802.1s), allows the bundling of multiple VLANs into one spanning tree topology. This concept is not new to Extreme Networks. Like MSTP, Extreme Networks proprietary EMISTP implementation can achieve the same capabilities of sharing a virtual network topology among multiple VLANs; however, MSTP overcomes some of the challenges facing EMISTP, including enhanced loop protection mechanisms and new capabilities to achieve better scaling.

MSTP logically divides a Layer 2 network into regions. Each region has a unique identifier and contains multiple spanning tree instances (MSTIs). An MSTI is a spanning tree domain that operates within and is bounded by a region. MSTIs control the topology inside the regions. The Common and Internal Spanning Tree (CIST) is a single spanning tree domain that interconnects MSTP regions. The CIST is responsible for creating a loop-free topology by exchanging and propagating BPDUs across regions to form a Common Spanning Tree (CST).

MSTP uses RSTP as its converging algorithm and is interoperable with the legacy STP protocols: STP (802.1D) and RSTP (802.1w). MSTP has three major advantages over 802.1D, 802.1w, and other proprietary implementations:

- To save control path bandwidth and provide improved scalability, MSTP uses regions to localize BPDU traffic. BPDUs containing information about MSTIs contained within an MSTP region do not cross that region's boundary.
- A single BPDU transmitted from a port can contain information for up to 64 STPDs. MSTP BPDU processing utilizes less resources compared to 802.1D or 802.1w where one BPDU corresponds to one STPD.
- In a typical network, a group of VLANs usually share the same physical topology. Dedicating a spanning tree per VLAN like PVST+ is CPU intensive and does not scale very well. MSTP makes it possible for a single STPD to handle multiple VLANs.

MSTP Concepts

This section describes the following MSTP concepts:

- [MSTP Regions on page 1043](#)
- [Common and Internal Spanning Tree on page 1044](#)
- [Multiple Spanning Tree Instances on page 1046](#)
- [Boundary Ports on page 1047](#)
- [MSTP Port Roles on page 1048](#)
- [MSTP Port States on page 1048](#)
- [MSTP Link Types on page 1049](#)
- [MSTP Edge Safeguard on page 1049](#)
- [MSTP Timers on page 1049](#)
- [MSTP Hop Counts on page 1049](#)
- [Configuring MSTP on the Switch on page 1049](#)

MSTP Regions

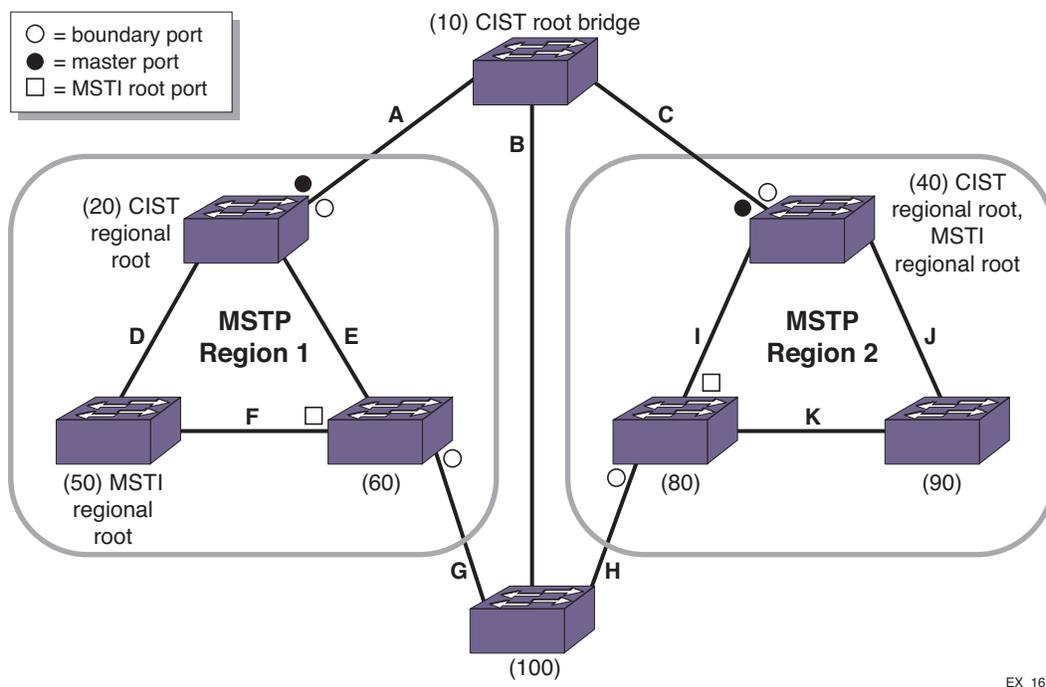
An MSTP network consists of either individual MSTP regions connected to the rest of the network with 802.1D and 802.1w bridges or as individual MSTP regions connected to each other. An MSTP region defines the logical boundary of the network. With MSTP, you can divide a large network into smaller areas similar to an OSPF area or a BGP Autonomous System, which contain a group of switches under a single administration. Each MSTP region has a unique identifier, is bound together by one CIST that spans the entire network. A bridge participates in only one MSTP region at a time.

An MSTP region can hide its internal STPDs and present itself as a virtual 802.1w bridge to other interconnected regions or 802.1w bridges because the port roles are encoded in 802.1w and MSTP BPDUs.

By default, the switch uses the MAC address of the switch to generate an MSTP region. Since each MAC address is unique, every switch is in its own region by default. For multiple switches to be part of an MSTP region, you must configure each switch in the region with the same MSTP region identifiers. See [“Configuring MSTP Region Identifiers” on page 1043](#) for information.

In [Figure 153](#), all bridges inside MSTP regions 1 and 2 are MSTP bridges; bridges outside of the regions are either 802.1D or 802.1w bridges.

Figure 153: Sample MSTP Topology with Two MSTP Regions



EX_167

Configuring MSTP Region Identifiers. For multiple switches to be part of an MSTP region, you must configure each switch in the region with the same MSTP configuration attributes, also known as MSTP region identifiers.

The following list describes the MSTP region identifiers:

- **Region Name**—This indicates the name of the MSTP region. In the Extreme Networks implementation, the maximum length of the name is 32 characters and can be a combination of alphanumeric characters and underscores (_).
- **Format Selector**—This indicates a number to identify the format of MSTP BPDUs. The default is 0.
- **Revision Level**—This identifier is reserved for future use; however, the switch uses and displays a default of 3.

The switches inside a region exchange BPDUs that contain information for MSTIs. The switches connected outside of the region exchange CIST information. By having devices look at the region identifiers, MSTP discovers the logical boundary of a region:

- **Configuring the MSTP region name**

To configure the MSTP region name, use the following command:

```
configure mstp region <regionName>
```

The maximum length of the region name is 32 characters and can be a combination of alphanumeric characters and underscores (_). You can configure only one MSTP region on the switch at any given time.

If you have an active MSTP region, Extreme Networks recommends that you disable all active STPDs in the region before renaming the region on all of the participating switches.

- **Configuring the MSTP BDU format identifier**

To configure the number used to identify MSTP BPDUs, use the following command:

```
configure mstp format <format_identifier>
```

By default, the value used to identify the MSTP BPDUs is 0. The range is 0 to 255.

If you have an active MSTP region, Extreme Networks recommends that you disable all active STPDs in the region before modifying the value used to identify MSTP BPDUs on all participating switches.

- **Configuring the MSTP revision level**

Although the `configure mstp revision <revision>` command is available on the CLI, this command is reserved for future use.

Unconfiguring an MSTP Region. Before you unconfigure an MSTP region, Extreme Networks recommends that you disable all active STPDs in the region.

To unconfigure the MSTP region on the switch, use the following command:

```
unconfigure mstp region
```

After you issue this command, all of the MSTP settings return to their default values. See [“Configuring MSTP Region Identifiers” on page 1043](#) for information about the default settings.

Common and Internal Spanning Tree

As previously described, MSTP logically divides a Layer 2 network into regions. The Common and Internal Spanning Tree (CIST) is a single spanning tree domain that interconnects MSTP regions. The CIST is responsible for creating a loop-free topology by exchanging and propagating BPDUs across regions to form a Common Spanning Tree (CST). In essence, the CIST is similar to having a large spanning tree across the entire network. The CIST has its own root bridge that is common to all MSTP

regions, and each MSTP region elects a CIST regional root that connects that region to the CIST thereby forming a CST.

The switch assigns the CIST an instance ID of 0, which allows the CIST to send BPDUs for itself in addition to all of the MSTIs within an MSTP region. Inside a region, the BPDUs contain CIST records and piggybacked M-records. The CIST records contain information about the CIST, and the M-records contain information about the MSTIs. Boundary ports exchange only CIST record BPDUs.

All MSTP configurations require a CIST domain. You must first configure the CIST domain before configuring any MSTIs. By default, all MSTI ports in the region are inherited by the CIST. You cannot delete or disable a CIST if any of the MSTIs are active in the system.

Configuring the CIST. To configure an STPD as the CIST, use the following command and specify the `mstp cist` keywords:

```
configure stpd <stpd_name> mode [dot1d | dot1w | mstp [cist | msti <instance>]]
```

You enable MSTP on a per STPD basis only. By specifying the `mstp cist` keywords, you configure the mode of operation for the STPD as MSTP, and you identify the STPD to be the CIST.

CIST Root Bridge. In a Layer 2 network, the bridge with the lowest bridge ID becomes the CIST root bridge. The parameters (vectors) that define the root bridge include the following:

- User-defined bridge priority (by default, the bridge priority is 32,768)
- MAC address

The CIST root bridge can be either inside or outside an MSTP region. The CIST root bridge is unique for all regions and non-MSTP bridges, regardless of its location.

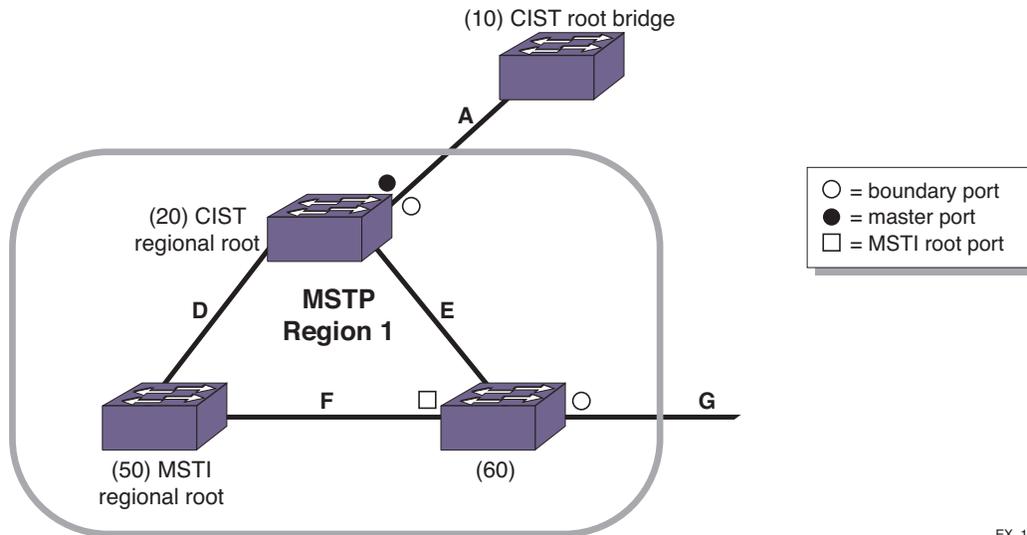
For more information about configuring the bridge ID, see the `configure stpd priority` command in the *ExtremeXOS Command Reference Guide*.

CIST Regional Root Bridge. Within an MSTP region, the bridge with the lowest path cost to the CIST root bridge is the CIST regional root bridge. The path cost, also known as the CIST external path cost, is a function of the link speed and number of hops. If there is more than one bridge with the same path cost, the bridge with the lowest bridge ID becomes the CIST regional root. If the CIST root is inside an MSTP region, the same bridge is the CIST regional root for that region because it has the lowest path cost to the CIST root. If the CIST root is outside an MSTP region, all regions connect to the CIST root via their CIST regional roots.

The total path cost to the CIST root bridge from any bridge in an MSTP region consists of the CIST internal path cost (the path cost of the bridge to the CIST regional root bridge) and the CIST external path cost. To build a loop-free topology within a region, the CIST uses the external and internal path costs, and the MSTI uses only the internal path cost.

Looking at MSTP region 1 in Figure 154, the total path cost for the bridge with ID 60 consists of an external path cost of A and an internal path cost of E.

Figure 154: Close-Up of MSTP Region 1



EX_168

CIST Root Port. The port on the CIST regional root bridge that connects to the CIST root bridge is the CIST root port (also known as the master port for MSTIs). The CIST root port is the master port for all MSTIs in that region, and it is the only port that connects the entire region to the CIST root.

If a bridge is both the CIST root bridge and the CIST regional root bridge, there is no CIST root port on that bridge.

Enabling the CIST. To enable the CIST, use the following command and specify the CIST domain as the <stpd_name>:

```
enable stpd {<stpd_name>}
```

Multiple Spanning Tree Instances

As previously described, multiple spanning tree instances (MSTIs) control the topology inside an MSTP region. An MSTI is a spanning tree domain that operates within and is bounded by a region; an MSTI does not exchange BPDUs with or send notifications to other regions. You identify an MSTI on a per region basis. The MSTI ID does not have any significance outside of its region so you can re-use IDs across regions. An MSTI consists of a group of VLANs, which can share the same network topology. Each MSTI has its own root bridge and a tree spanning its bridges and LAN segments.

You must first configure a CIST before configuring any MSTIs in the region. You cannot delete or disable a CIST if any of the MSTIs are active in the system.

You can map multiple VLANs to an MSTI; however, multiple MSTIs cannot share the same VLAN.

Configuring the MSTI and the MSTI ID. MSTP uses the MSTI ID, not an Stpd ID, to identify the spanning tree contained within the region. As previously described, the MSTI ID only has significance within its local region, so you can re-use IDs across regions.

To configure the MSTI that is inside an MSTP region and its associated MSTI ID, use the following command and specify the `mstp [msti <instance>]` parameters:

```
configure stpd <stpd_name> mode [dot1d | dot1w | mstp [cist | msti <instance>]]
```

The range of the MSTI instance ID is 1 to 4,094.

MSTP STPDs use 802.1D BPDU encapsulation mode by default. To ensure correct operation of your MSTP STPDs, do not configure EMISTP or PVST+ encapsulation mode for MSTP STPDs. For more information, see [“Encapsulation Modes” on page 1017](#).

MSTI Regional Root Bridge. Each MSTI independently chooses its own root bridge. For example, if two MSTIs are bounded to a region, there is a maximum of two MSTI regional roots and one CIST regional root.

The bridge with the lowest bridge ID becomes the MSTI regional root bridge. The parameters that define the root bridge include the following:

- User-defined bridge priority (by default, the bridge priority is 32,768)
- MAC address

Within an MSTP region, the cost from a bridge to the MSTI regional root bridge is known as the MSTI internal path cost. Looking at MSTP region 1 in [Figure 154 on page 1046](#), the bridge with ID 60 has a path cost of F to the MSTI regional root bridge.

The MSTI regional root bridge can be the same as or different from the CIST regional root bridge of that region. You achieve this by assigning different priorities to the STP instances configured as the MSTIs and the CIST. For more information about configuring the bridge ID, see the `configure stpd priority` command in the *ExtremeXOS Command Reference Guide*.

MSTI Root Port. The port on the bridge that has the lowest path cost to the MSTI regional root bridge is the MSTI root port. If a bridge has two or more ports with the same path cost, the port with the best port identifier becomes the root port.

Enabling the MSTI. To enable the MSTI, use the following command and specify the MSTI domain as the `<stpd_name>`:

```
enable stpd {<stpd_name>}
```



NOTE

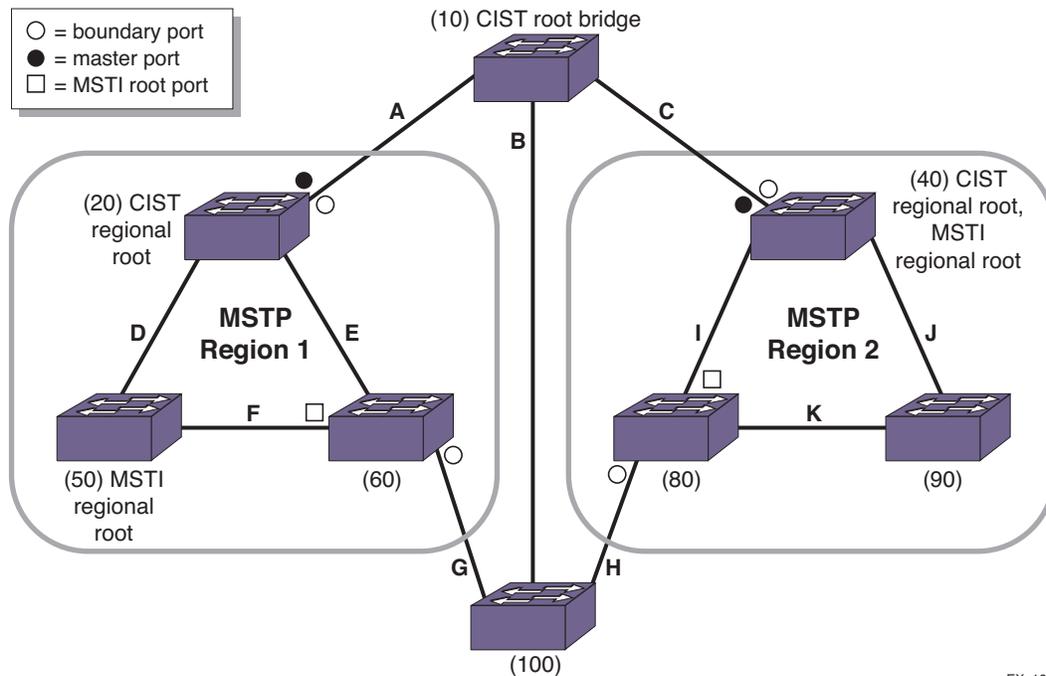
If two switches are configured for the same CIST and MSTI region, in order for them to understand that they are in the same region, both must also belong to the same VLAN which is added to the STP domain. If they belong to different VLANs, each switch believes that each belongs to a different region. When an MSTP BPDU is sent, it carries a VID digest created by VLAN memberships in the CIST domain and the MSTI domain.

Boundary Ports

Boundary ports are bridge ports that are only connected to other MSTP regions or 802.1D or 802.1w bridges. The ports that are not at a region boundary are called internal ports. The boundary ports exchange only CIST BPDUs. A CIST BPDU originated from the CIST root enters a region through the CIST root port and egresses through boundary ports. This behavior simulates a region similar to an 802.1w bridge, which receives BPDUs on its root ports and forwards updated BPDUs on designated ports.

Figure 155 shows an MSTP network that consists of two MSTP regions. Each region has its own CIST regional root and is connected to the CIST root through master ports. The CIST regional roots in each region are the MSTP bridges having the lowest CIST external root path cost. The CIST root is the bridge with the lowest bridge ID and is an 802.1w bridge outside of either MSTP region.

Figure 155: Sample MSTP Topology with Two MSTP Regions



EX_167

MSTP Region 1 and MSTP Region 2 are connected to the CIST root through directly connected ports, identified as master ports. The bridge with ID 100 connects to the CIST root through Region 1, Region 2, or segment B. For this bridge, either Region 1 or Region 2 can be the designated region or segment B can be the designated segment. The CIST BPDUs egressing from the boundary ports carry the CIST regional root as the designated bridge. This positions the entire MSTP region as one virtual bridge.

The CIST controls the port roles and the state of the boundary ports. A master port is always forwarding for all CIST and MSTI VLANs. If the CIST sets a boundary port to the discarding state, the CIST blocks traffic for all VLANs mapped to it and the MSTIs within that region. Each MSTI blocks traffic for their member VLANs and puts their internal ports into the forwarding or blocking state depending on the MSTI port roles. For more information about port states, see [“MSTP Port States” on page 1048](#).

MSTP Port Roles

MSTP uses the same port roles as RSTP (Root, Designated, Alternate, and Backup), as described in [Table 106 on page 1031](#). In addition to those port roles, MSTP introduces a new port role: Master. A Master port is the port that connects an MSTI to the CIST root.

MSTP Port States

MSTP uses the same port states as RSTP (Listening, Learning, Forwarding, and Blocking). In the Extreme Networks MSTP implementation, the listening state is not truly implemented as FDB learning

cannot be done when the port is not in the forwarding state. Ports in the blocking state listen but do not accept ingress traffic, perform traffic forwarding, or learn MAC source address; however, the port receives and processes BPDUs. For more information about all of the STP port states, see [“STP States” on page 1018](#).

MSTP Link Types

MSTP uses the same link types as STP and RSTP, respectively. In an MSTP environment, configure the same link types for the CIST and all MSTIs. For more information about the link types, see [“Link Types” on page 1032](#).

MSTP Edge Safeguard

You can configure edge safeguard for loop prevention and detection on an MSTP edge port. For more information see [“Configuring Edge Safeguard” on page 1033](#).



NOTE

In MSTP, configuring edge safeguard at CIST will be inherited in all MSTI. In MSTP, an edge port needs to be added to a CIST before adding it to an MSTI.

MSTP Timers

MSTP uses the same timers as STP and RSTP, respectively. For more information, see [“RSTP Timers” on page 1034](#).

MSTP Hop Counts

In an MSTP environment, the hop count has the same purpose as the maxage timer for 802.1D and 802.1w environments. The CIST hop count is used within and outside a region. The MSTI hop count is used only inside of the region. In addition, if the other end is an 802.1D or 802.1w bridge, the maxage timer is used for interoperability between the protocols.

The BPDUs use hop counts to age out information and to notify neighbors of a topology change. To configure the hop count, use the following command:

```
configure stpd <stpd_name> max-hop-count <hopcount>
```

By default, the hop count of a BPDU is 20 hops. The range is 6 to 40 hops.

Configuring MSTP on the Switch

To configure and enable MSTP:

- 1 Create the MSTP region using the following command:

```
configure mstp region <regionName>
```

- 2 Create and configure the CIST, which forms the CST, using the following commands:

```
create stpd <stpd_name> {description <stpd-description>}
```

```
configure stpd <stpd_name> mode mstp cist
```

**NOTE**

You can configure the default STPD, S0 as the CIST.

**NOTE**

No VLAN can be bound to the CIST and no ports can be added to the CIST. Therefore, the VLAN should be bound to the MSTI and the “show MSTI port” command will show the VLAN ports. The ports added to the MSTI are bound automatically to the CIST even though they are not added to it.

3 Enable the CIST using the following command:

```
enable stpd {<stpd_name>}
```

4 Create and configure MSTIs using the following commands:

```
create stpd <stpd_name> {description <stpd-description>}
```

```
configure stpd <stpd_name> mode mstp msti <instance>
```

5 Add VLANs to the MSTIs using one of the following commands:

- Manually binding ports

```
configure stpd <stpd_name> add vlan <vlan_name> ports [all | <port_list>] {[dot1d  
| emistp | pvst-plus]}
```

```
configure vlan <vlan_name> add ports [all | <port_list>] {tagged | untagged} stpd  
<stpd_name> {[dot1d | emistp | pvst-plus]}
```

- Automatically binding ports to an STPD when ports are added to a member VLAN

```
enable stpd <stpd_name> auto-bind vlan <vlan_name>
```

6 Enable the MSTIs.

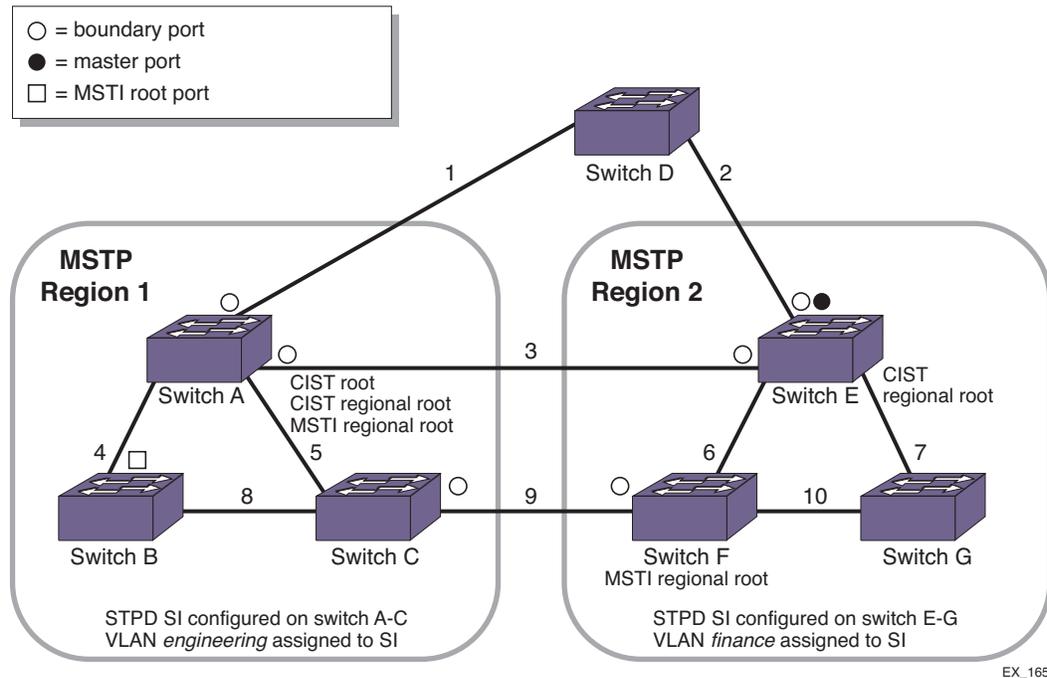
```
enable stpd {<stpd_name>}
```

For a more detailed configuration example, see “MSTP Configuration Example” on page 1062.

MSTP Operation

To further illustrate how MSTP operates and converges, [Figure 156](#) displays a network with two MSTP regions. Each region contains three MSTP bridges and one MSTI. The overall network topology also contains one CIST root bridge (Switch A, which has the lowest bridge ID), one interconnecting 802.1w bridge (Switch D), and 10 full duplex, point-to-point segments. VLAN Default spans all of the bridges and segments in the network, VLAN engineering is local to its respective region, and STPD S0 is configured as the CIST on all bridges.

Figure 156: MSTP Topology with the CIST Root Bridge Contained within a Region



MSTP Region 1 consists of the following:

- Three bridges named Switch A, Switch B, and Switch C
- One MSTI STPD named S1 with an MSTI ID of 1
- VLAN *Engineering* mapped to the MSTI STPD, S1
- Switch A as the CIST root bridge (this is the CIST root bridge for all regions)
- Switch A as the CIST regional root bridge
- Switch A as the MSTI regional root bridge
- Three boundary ports that connect to MSTP region 2 and other 802.1D or 802.1w bridges

MSTP Region 2 consists of the following:

- Three bridges named Switch E, Switch F, and Switch G
- One MSTI STPD named S1 with an MSTI ID of 1



NOTE

The MSTI ID does not have any significance outside of its region so you can re-use IDs across regions.

- VLAN *finance* mapped to the MSTI STPD, S1
- Switch E as the CIST regional root bridge
- Switch F as the MSTI regional root bridge
- One master port that connects to the CIST
- Three boundary ports that connect to MSTP region 1 and other 802.1D or 802.1w bridges

The following sequence describes how the MSTP topology convergences:

1 Determining the CIST root bridge, MSTP regions, and region boundaries.

Each bridge believes that it is the root bridge, so each bridge initially sends root bridge BPDUs throughout the network. As bridges receive BPDUs and compare vectors, the bridge with the lowest Bridge ID is elected the CIST root bridge. In our example, Switch A has the lowest Bridge ID and is the CIST root bridge.

The bridges in the MSTP regions (Switches A, B, C, E, F, and G) advertise their region information along with their bridge vectors.

Segments 1, 3, and 9 receive BPDUs from other regions and are identified as boundary ports for region 1. Similarly, segments 2, 3, and 9 are identified as boundary ports for region 2.

2 Controlling boundary ports.

The CIST regional root is advertised as the Bridge ID in the BPDUs exiting the region. By sending CIST BPDUs across regional boundaries, the CIST views the MSTP regions as virtual 802.1w bridges. The CIST takes control of the boundary ports and only CIST BPDUs enter or exit a region boundary.

Each MSTP region has a CIST regional root bridge that communicates to the CIST root bridge. The bridge with the lowest path cost becomes the CIST regional root bridge. The port on the CIST regional root bridge that connects to the CIST root bridge is the CIST root port.

For region 1, Switch A has the lowest cost (0 in this example) and becomes the CIST regional root. Since the bridge is both the CIST root bridge and the CIST regional root bridge, there is no CIST root port on the bridge.

For region 2, Switch E is the CIST regional root bridge and so a port on that bridge becomes the CIST root port.

3 Identifying MSTI regional roots.

Each MSTI in a region has an MSTI regional root bridge. MSTI regional roots are selected independently of the CIST root and CIST regional root. The MSTP BPDUs have M-records for each MSTI. Bridges belonging to an MSTI compare vectors in their M-records to elect the MSTI regional root.

4 Converging the CIST.

The CIST views every region as a virtual bridge and calculates the topology using the 802.1w algorithm. The CIST calculates the topology both inside and outside of a region.

5 Converging MSTIs.

After the CIST identifies the boundary ports, each MSTI in a domain converge their own trees using 802.1w.

At this point, all CIST and MSTIs have assigned port roles of root, designated, alternate, and backup to their respective spanning trees. All root and designated ports transition to the forwarding state while the remaining ports remain in the discarding state.

Propagating topology change information is similar to that described for RSTP. For more information see, [“Propagating Topology Change Information” on page 1037](#).

For a configuration example, see [“MSTP Configuration Example” on page 1062](#).

STP and Network Login

STP and network login can be enabled on the same port. This feature can be used to prevent loops while providing redundancy and security on aggregated as well as end switches.

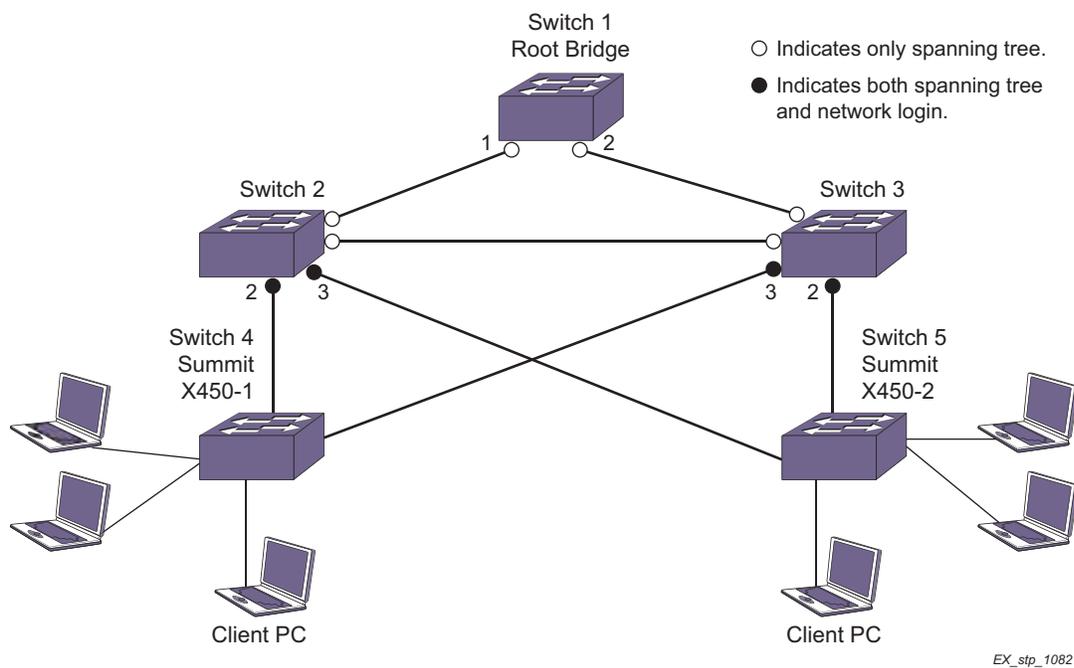


NOTE

You should be aware that an STP topology change will affect the network login clients. See [STP Rules and Restrictions](#) for further information.

Figure 157 shows STP and network login enabled on ports 2 and 3 of Switch 2 and Switch 3 for a typical aggregation scenario.

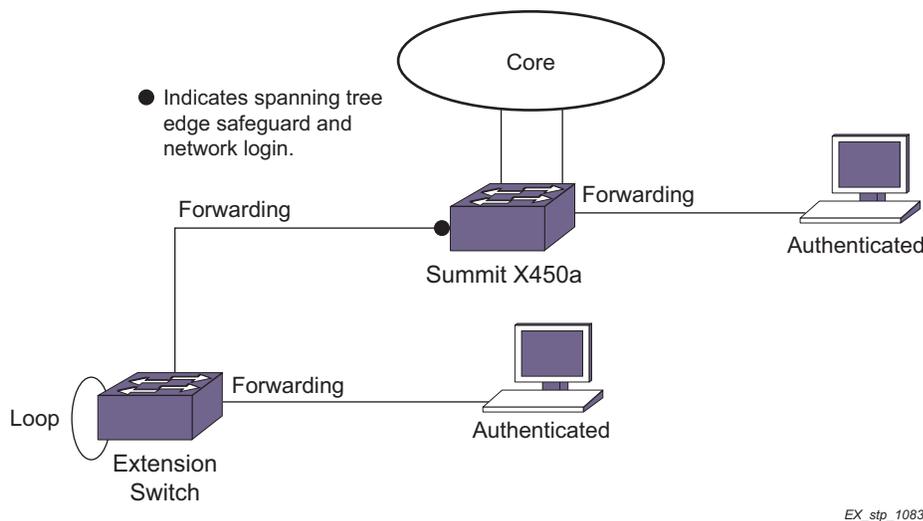
Figure 157: STP and Network Login Enabled



This relieves the administrator from having to configure network login on all the edge ports. All the traffic can be monitored and resiliency is provided at the aggregation side.

Figure 158 shows a typical scenario for protecting loops and monitoring traffic on the edge side.

Figure 158: Traffic Monitoring on the Edge Side



In huge networks, it is not easy to control or prevent end users from connecting devices other than workstations to the edge ports. This feature helps in preventing the network loops that occur when end users connect a switch or hub to the existing edge port in order to increase the number of end user ports.

STP Rules and Restrictions

This section summarizes the rules and restrictions for configuring STP as follows:

- The carrier VLAN must span all ports of the STPD. (This is not applicable to MSTP.)
- The StpdID must be the VLAN ID of the carrier VLAN; the carrier VLAN cannot be partitioned. (This is not applicable to MSTP.)
- A default VLAN cannot be partitioned. If a VLAN traverses multiple STPDs, the VLAN must be tagged.
- An STPD can carry, at most, one VLAN running in PVST+ mode, and its STPD ID must be identical with that VLAN ID. In addition, the PVST+ VLAN cannot be partitioned.
- The default VLAN of a PVST+ port must be identical to the native VLAN on the PVST+ device connected to that port.
- If an STPD contains both PVST+ and non-PVST+ ports, that STPD must be enabled. If that STPD is disabled, the BPDUs are flooded in the format of the incoming STP port, which may be incompatible with those of the connected devices.
- The 802.1D ports must be untagged; and the EMISTP/PVST+ ports must be tagged in the carrier VLAN.
- An STPD with multiple VLANs must contain only VLANs that belong to the same virtual router instance.

- STP and network login operate on the same port as follows:
 - STP (802.1D), RSTP (802.1W), and MSTP (802.1S) support both network login and STP on the same port.
 - At least one VLAN on the intended port should be configured both for STP and network login.
 - STP and network login operate together only in network login ISP mode.
 - When STP blocks a port, network login does not process authentication requests. All network traffic is blocked except STP BPDUs.
 - When STP places a port in forwarding state, all network traffic is allowed and network login starts processing authentication requests.
- STP cannot be configured on the following ports:
 - A mirroring target port.
 - A software-controlled redundant port.
- When you are using the older method of enabling STP instead of EAPSV2 to block the super loop in a shared-port environment, you can continue to do so. In all other scenarios, it is not recommended to use both STP and EAPS on the same port.
- MSTP and 802.1D STPDs cannot share a physical port.
- Only one MSTP region can be configured on a switch.
- In an MSTP environment, A VLAN can belong to one of the MSTIs.
- A VLAN can belong to only one MSTP domain.
- MSTP is not interoperable with PVST+.
- No VLAN can be bound to the CIST.

Configuring STP on the Switch

To configure basic STP:

- 1 Create one or more STPDs using the following command:

```
create stpd <stpd_name> {description <stpd-description>}
```

- 2 Add one or more VLANs to the STPD using the following command:

```
configure stpd <stpd_name> add vlan <vlan_name> ports [all | <port_list>] {[dot1d  
| emistp | pvst-plus]}
```

- 3 Define the carrier VLAN using the following command:

```
configure stpd <stpd_name> tag <stpd_tag>
```



NOTE

The carrier VLAN's ID must be identical to the ID of the STPD.

- 4 Enable STP for one or more STPDs using the following command:

```
enable stpd {<stpd_name>}
```

After you have created the STPD, you can optionally configure STP parameters for the STPD.

**NOTE**

You should not configure any STP parameters unless you have considerable knowledge and experience with STP. The default STP parameters are adequate for most networks.

The following parameters can be configured on each STPD:

- Hello time (In an MSTP environment, configure this only on the CIST.)
- Forward delay
- Max age (In an MSTP environment, configure this only on the CIST.)
- Max hop count (MSTP only)
- Bridge priority
- Domain description
- StpdID (STP, RSTP, EMISTP, and PVST+ only)
- MSTI ID (MSTP only)

The following parameters can be configured on each port:

- Path cost
- Port priority
- Port mode

**NOTE**

The device supports the RFC 1493 Bridge MIB, RSTP-03, and Extreme Networks STP MIB. Parameters of the s0 default STPD support RFC 1493 and RSTP-03. Parameters of any other STPD support the Extreme Networks STP MIB.

**NOTE**

If an STPD contains at least one port not in 802.1D (dot1D) mode, the STPD must be configured with an StpdID.

The following section provides more detailed STP configuration examples, including 802.1D, EMISTP, RSTP, and MSTP.

STP FDB Flush Criteria

When there are more than 1000 VLANs and more than 70 ports participating in STP, the number of messages exchanged between STP/FDB/HAL modules can consume a lot of system memory when trying to flush the FDB during a STP topology change. To help avoid this high consumption, you can set the flush type from the default of `vlan-and-port` to `port-based`.

To set the flush type, use the following command:

```
configure stpd flush-method [vlan-and-port | port-only]
```

Displaying STP Settings

To display STPD settings, use the following command:

```
show stpd {<stpd_name> | detail}
```

To display more detailed information for one or more STPDs, specify the `detail` option.

This command displays the following information:

- STPD name
- STPD state
- STPD mode of operation
- Domain description
- Rapid Root Failover
- Tag
- Ports
- Active VLANs
- Bridge Priority
- Bridge ID
- Designated root
- STPD configuration information

If you have MSTP configured on the switch, this command displays additional information:

- MSTP Region
- Format Identifier
- Revision Level
- Common and Internal Spanning Tree (CIST)
- Total number of MST Instances (MSTI)

To display the state of a port that participates in STP, use the following command:

```
show {stpd} <stpd_name> ports {[detail | <port_list> {detail}]}
```

To display more detailed information for one or more ports in the specified STPD, including participating VLANs, specify the `detail` option.

This command displays the following information:

- STPD port configuration
- STPD port mode of operation
- STPD path cost
- STPD priority
- STPD state (root bridge, and so on)
- Port role (root designated, alternate and so on)
- STPD port state (forwarding, blocking, and so on)
- Configured port link type
- Operational port link type

- Edge port settings (inconsistent behavior, edge safeguard setting)
- MSTP port role (internal or boundary)

If you have MSTP configured and specify the `detail` option, this command displays additional information:

- MSTP internal path cost
- MSTP timers
- STPD VLAN Settings

If you have a VLAN that spans multiple STPDs, use the `show {vlan} <vlan_name> stpd` command to display the STP configuration of the ports assigned to that specific VLAN.

The command displays the following:

- STPD port configuration
- STPD port mode of operation
- STPD path cost
- STPD priority
- STPD state (root bridge, and so on)
- Port role (root designated, alternate and so on)
- STPD port state (forwarding, blocking, and so on)
- Configured port link type
- Operational port link type

STP Configuration Examples

This section provides four configuration examples:

- [Basic 802.1D Configuration Example on page 1058](#)
- [EMISTP Configuration Example on page 1059](#)
- [RSTP 802.1w Configuration Example on page 1060](#)
- [MSTP Configuration Example on page 1062](#)

Basic 802.1D Configuration Example

The following example:

- Removes ports from the VLAN *Default* that will be added to VLAN *Engineering*.
- Creates the VLAN *Engineering*.
- Assigns a VLAN ID to the VLAN *Engineering*.



NOTE

If you do not explicitly configure the VLAN ID in your 802.1D deployment, use the `show vlan` command to see the internal VLAN ID automatically assigned by the switch.

- Adds ports to the VLAN *Engineering*.

- Creates an STPD named *Backbone_st*.
- Configures the default encapsulation mode of dot1d for all ports added to STPD *Backbone_st*.
- Enables autobind to automatically add or remove ports from the STPD.
- Assigns the *Engineering* VLAN to the STPD.
- Assigns the carrier VLAN.

**NOTE**

To assign the carrier VLAN, the StpdID must be identical to the VLAN ID of the carrier VLAN.

- Enables STP.

```
configure vlan default delete ports 2:5-2:10
create vlan engineering
configure vlan engineering tag 150
configure vlan engineering add ports 2:5-2:10 untagged
```

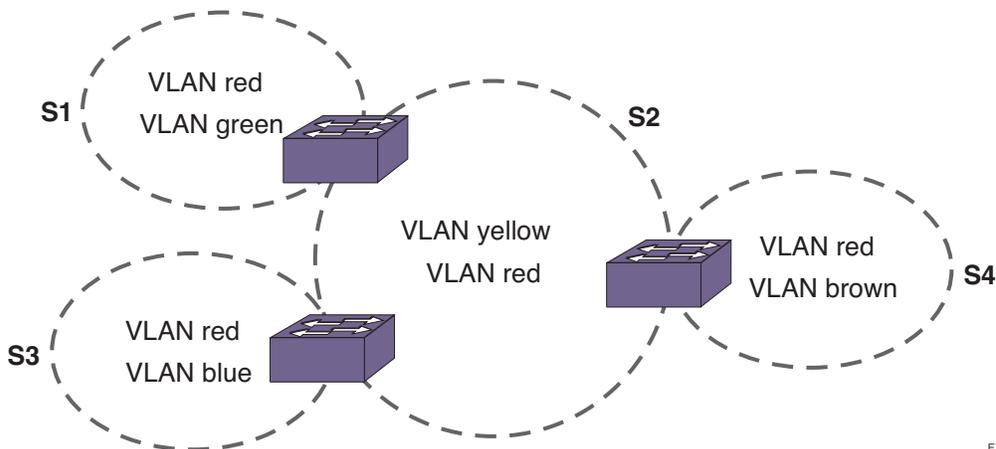
```
create stpd backbone_st
configure stpd backbone_st default-encapsulation dot1d
enable stpd backbone_st auto-bind vlan engineering
configure stpd backbone_st tag 150
enable stpd backbone_st
```

By default, the port encapsulation mode for user-defined STPDs is *emistp*. In this example, you set it to *dot1d*.

EMISTP Configuration Example

Figure 159 is an example of EMISTP.

Figure 159: EMISTP Configuration Example



EX_051

**NOTE**

By default, all ports added to a user-defined STPD are in *emistp* mode, unless otherwise specified.

The following commands configure the switch located between S1 and S2:

```
create vlan red
configure red tag 100
configure red add ports 1:1-1:4 tagged

create vlan green
configure green tag 200
configure green add ports 1:1-1:2 tagged

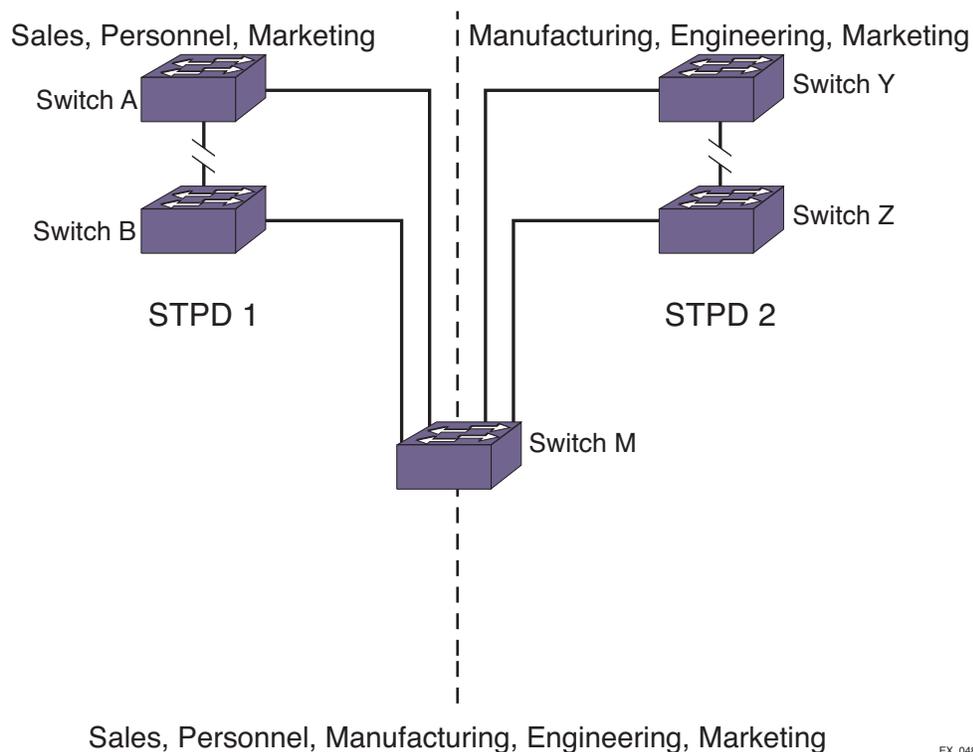
create vlan yellow
configure yellow tag 300
configure yellow add ports 1:3-1:4 tagged
create stpd s1
configure stpd s1 add green ports all
configure stpd s1 tag 200
configure stpd s1 add red ports 1:1-1:2 emistp
enable stpd s1

create stpd s2
configure stpd s2 add yellow ports all
configure stpd s2 tag 300
configure stpd s2 add red ports 1:3-1:4 emistp
enable stpd s2
```

RSTP 802.1w Configuration Example

Figure 160 is an example of a network with multiple STPDs that can benefit from RSTP. For RSTP to work:

- Create an STPD.
- Configure the mode of operation for the STPD.
- Create the VLANs and assign the VLAN ID and the VLAN ports.
- Assign the carrier VLAN.
- Add the protected VLANs to the STPD.
- Configure the port link types.
- Enable STP.

Figure 160: RSTP Example

EX_048

In this example, the commands configure switch A in STPD1 for rapid reconvergence. Use the same commands to configure each switch and STPD in the network.

```

create stpd stpd1
configure stpd stpd1 mode dot1w

create vlan sales
create vlan personnel
create vlan marketing
configure vlan sales tag 100
configure vlan personnel tag 200
configure vlan marketing tag 300
configure vlan sales add ports 1:1,2:1 tagged
configure vlan personnel add ports 1:1,2:1 tagged
configure vlan marketing add ports 1:1,2:1 tagged

configure stpd stpd1 add vlan sales ports all
configure stpd stpd1 add vlan personnel ports all
configure stpd stpd1 add vlan marketing ports all

configure stpd stpd1 ports link-type point-to-point 1:1,2:1

configure stpd stpd1 tag 100

enable stpd stpd1

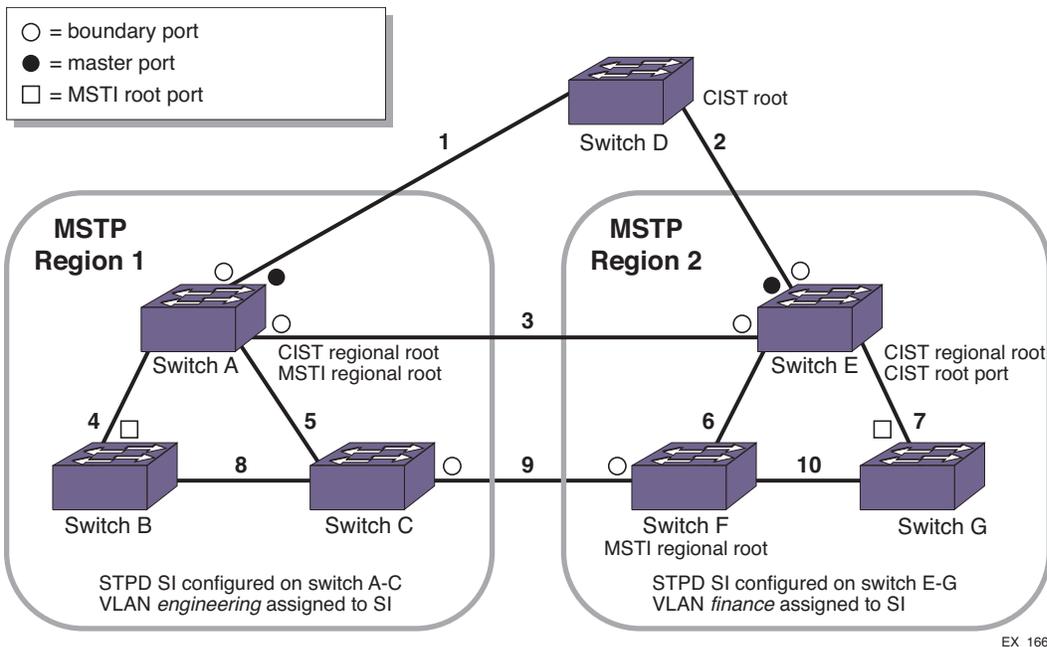
```

MSTP Configuration Example

You must first configure a CIST before configuring any MSTIs in the region. You cannot delete or disable a CIST if any of the MSTIs are active in the system.

Figure 161 is an example with multiple STPDs that can benefit from MSTP. In this example, we have two MSTP regions that connect to each other and one external 802.1w bridge.

Figure 161: MSTP Configuration Example



For MSTP to work, complete the following steps on all switches in Region 1 and Region 2:

- Remove ports from the VLAN Default that will be added to VLAN *Engineering*.
- Create the VLAN *Engineering*.
- Assign a VLAN ID to the VLAN *Engineering*.



NOTE

If you do not explicitly configure the VLAN ID in your MSTP deployment, use the `show vlan` command to see the internal VLAN ID automatically assigned by the switch.

- Add ports to the VLAN *Engineering*.
- Create the MSTP region.



NOTE

You can configure only one MSTP region on the switch at any given time.

- Create the STPD to be used as the CIST, and configure the mode of operation for the STPD.
- Specify the priority for the CIST.

- Enable the CIST.
- Create the STPD to be used as an MSTI and configure the mode of operation for the STPD.
- Specify the priority for the MSTI.
- Assign the VLAN *Engineering* to the MSTI.
- Configure the port link type.
- Enable the MSTI.

On the external switch (the switch that is not in a region):

- Create an STPD that has the same name as the CIST, and configure the mode of operation for the STPD.
- Specify the priority of the STPD.
- Enable the STPD.



NOTE

In the following sample configurations, any lines marked (Default) represent default settings and do not need to be explicitly configured. STPD s0 already exists on the switch.

In the following example, the commands configure Switch A in Region 1 for MSTP. Use the same commands to configure each switch in Region 1:

```
create vlan engineering
configure vlan engineering tag 2
configure vlan engineering add port 2-3 tagged

configure mstp region region1
create stpd s0 (Default)
disable stpd s0 auto-bind vlan Default
configure stpd s0 mode mstp cist
configure stpd s0 priority 32768 (Default)
enable stpd s0

create stpd s1
configure stpd s1 mode mstp msti 1
configure stpd s1 priority 32768 (Default)
enable stpd s1 auto-bind vlan engineering
configure stpd s1 ports link-type point-to-point 2-3
enable stpd s1
```

In the following example, the commands configure Switch E in Region 2 for MSTP. Use the same commands to configure each switch in Region 2:

```
create vlan finance
configure vlan finance tag 2
configure vlan finance add port 2-3 tagged

configure mstp region region2
create stpd s0 (Default)
configure stpd s0 mode mstp cist
configure stpd s0 priority 32768 (Default)
enable stpd s0 auto-bind vlan Default
enable stpd s0
```

```
create stpd s1
configure stpd s1 mode mstp msti 1
configure stpd s1 priority 32768 (Default)
enable stpd s1 auto-bind vlan finance
configure stpd s1 ports link-type point-to-point 2-3
enable stpd s1
```

In the following example, the commands configure switch D, the external switch. Switch D becomes the CIST root bridge:

```
create stpd s0 (Default)
configure stpd s0 mode dot1w
configure stpd s0 priority 28672
enable stpd s0 auto-bind vlan Default
configure stpd s0 ports link-type point-to-point 4-5
enable stpd s0
```

28

CHAPTER

ESRP

This chapter includes the following sections:

- [Overview on page 1065](#)
- [Configuring ESRP on page 1077](#)
- [Operation with Other ExtremeXOS Features on page 1081](#)
- [Advanced ESRP Features on page 1085](#)
- [Displaying ESRP Information on page 1091](#)
- [ESRP Configuration Examples on page 1092](#)

Overview

The Extreme Standby Router Protocol™ (ESRP), like the Virtual Router Redundancy Protocol (VRRP), allows multiple switches to provide redundant routing services to users. ESRP is used to eliminate the single point of failure associated with manually configuring a default gateway address on each host in a network. Without using ESRP, if the configured default gateway fails, you must reconfigure each host on the network to use a different router as the default gateway. ESRP provides a redundant path for the hosts. Using ESRP, if the default gateway fails, the backup router assumes forwarding responsibilities.

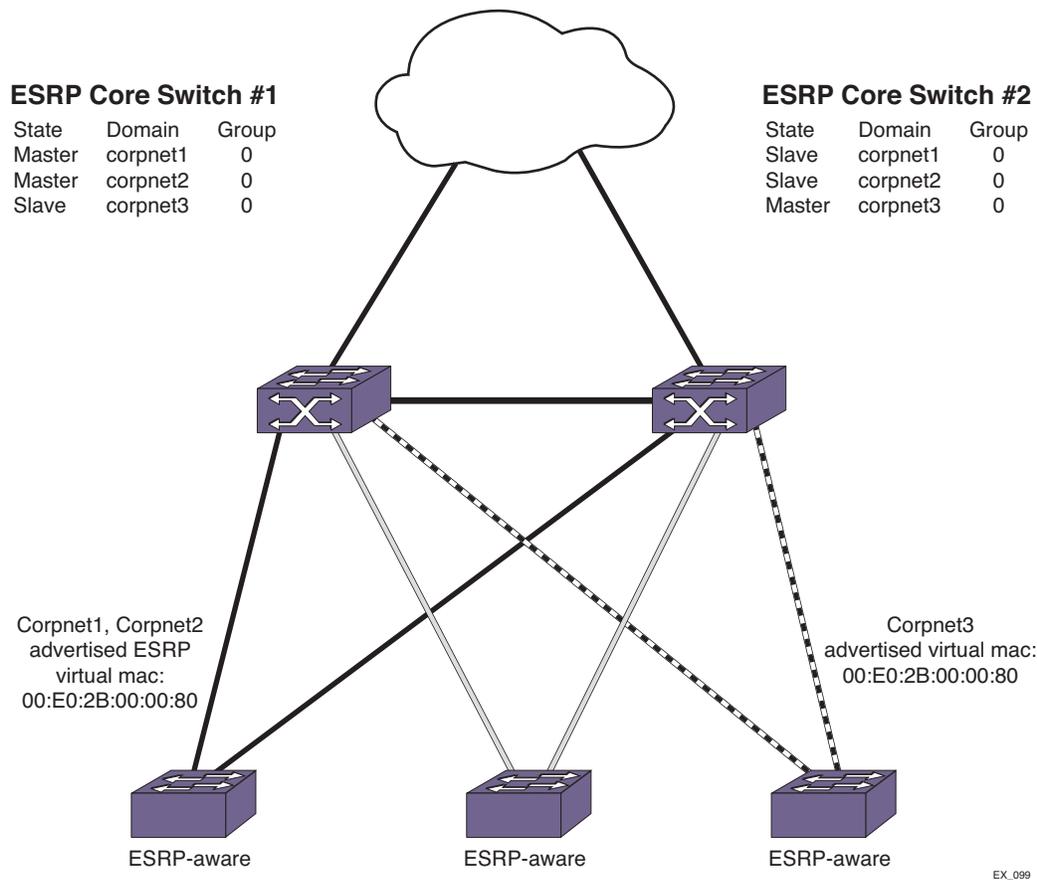
In addition to providing Layer 3 routing redundancy for IP and IPX, ESRP also provides Layer 2 redundancy features for fast failure recovery and to provide for dual-homed system design. In some instances, depending on network system design, ESRP can provide better resiliency than using Spanning Tree Protocol (STP) or Virtual Router Redundancy Protocol (VRRP). You can use Layer 3 and Layer 2 redundancy features in combination or independently. ESRP is available only on Extreme Networks switches. An example ESRP topology is shown in [Figure 162](#).



NOTE

Support for ESRP operation over IPv6 networks was added in ExtremeXOS release 12.6.

Figure 162: Example of a Basic ESRP Topology



In [Figure 162](#), ESRP Core Switch #1 and ESRP Core Switch #2 are both configured with three ESRP domains. Each domain represents a separate ESRP instance and supports a unique set of VLANs. Each domain is configured to use one master VLAN and can support additional member VLANs. The switches exchange keep-alive packets for each VLAN independently.

Unless groups are configured, each ESRP domain supports two routers, one operating in the master state, and one operating in the slave state. Within an ESRP domain, any ESRP router can become the *master*, but only one ESRP router can be master at a time. Only the master can actively provide Layer 3 routing and/or Layer 2 switching for each VLAN. The master handles the forwarding, ARP requests, NDP messages, and routing for a particular VLAN. The slave router stands by, ready to take over if the master is no longer available.

Each switch in an ESRP topology has its own unique IP address or IPX NetID and a MAC address, which are required for basic IP connectivity. For each ESRP domain, there is a shared virtual IP address or IPX NetID and a MAC address, which are used for network client communications. The *virtual IP address* or IPX NetID is configured on all ESRP routers in a domain, and it is configured as the default gateway address on network clients in that domain. If the master ESRP router becomes unavailable, the backup ESRP router takes over using the same virtual IP address or IPX NetID.

The topology in [Figure 162](#) shows that one switch serves as the master for the corpnet1 and corpnet2 domains, and the other switch serves as master for the corpnet3 domain. This topology demonstrates the load sharing capability of ESRP. If one switch served as master for all ESRP domains, all traffic would be routed through that master, and the slave switch would be idle. Dividing the ESRP domain

mastership between routers allows domain clients access to more bandwidth and reduces the likelihood of exceeding the capacity of a single master router.

You can use ESRP to achieve edge-level or aggregation-level redundancy. Deploying ESRP in this area of the network allows you to simplify your network design, which is important in designing a stable network. ESRP also works well in meshed networks where Layer 2 loop protection and Layer 3 redundancy are simultaneously required.

**NOTE**

For complete information about platform support for ESRP, see [Appendix A, “Feature License Requirements.”](#)

The following sections provide additional information on ESRP Concepts:

- [ESRP Master Election on page 1067](#)
- [ESRP Domains on page 1071](#)
- [ESRP Groups on page 1072](#)
- [ESRP Extended Mode Features on page 1073](#)
- [Linking ESRP Switches on page 1075](#)
- [ESRP and Hitless Failover on page 1075](#)
- [ESRP-Aware Switches on page 1076](#)
- [ExtremeWare Compatibility on page 1077](#)

ESRP Master Election

The system determines the ESRP master switch (providing Layer 3 routing and/or Layer 2 switching services for a VLAN) using the following default factors:

- **Stickiness**—The switch with the higher sticky value has higher priority. When an ESRP domain claims master, its sticky value is set to 1 (available only in extended mode).
- **Active ports**—The switch that has the greatest number of active ports takes highest precedence.
- **Tracking information**—Various types of tracking are used to determine if the switch performing the master ESRP function has connectivity to the outside world. ExtremeXOS software supports the following types of tracking:
 - **VLAN**—Tracks any active port connectivity to one designated VLAN. An ESRP domain can track one VLAN, and the tracked VLAN should not be a member of any other ESRP domain in the system.
 - **IP unicast route table entry**—Tracks specific learned routes from the IP route table.
 - **Ping**—Tracks ICMP ping connectivity to specified devices.
 - **Environment (health checks)**—Tracks the environment of the switch, including power supply and chassis temperature.

If any of the configured tracking mechanisms fail, the master ESRP switch relinquishes status as master, and remains in slave mode for as long as the tracking mechanism continues to fail.

- **ESRP priority**—This is a user-defined field. The range of the priority value is 0 to 255; a higher number has higher priority, except for 255. The default priority setting is 0. A priority setting of 255 makes an ESRP switch a standby switch that remains in slave mode until you change the priority setting. Extreme Networks recommends this setting for system maintenance. A switch with a priority setting of 255 will never become the master.

- System MAC address—The switch with the higher MAC address has higher priority.
- Active port weight—The switch that has the highest port weight takes precedence. The bandwidth of the port automatically determines the port weight (available only in extended mode).

You can configure the precedence order of the factors used by the system to determine the master ESRP switch. For more information about configuring the ESRP election metrics, see [“ESRP Election Algorithms” on page 1070](#).

The following sections provide more information on selecting the ESRP master:

- [Master Switch Behavior on page 1068](#)
- [Pre-Master Switch Behavior on page 1068](#)
- [Slave Switch Behavior on page 1068](#)
- [Neutral Switch Behavior on page 1068](#)
- [Electing the Master Switch on page 1069](#)
- [ESRP Failover Time on page 1069](#)
- [ESRP Election Algorithms on page 1070](#)

Master Switch Behavior

If a switch is master, it actively provides Layer 3 routing services to other VLANs, and Layer 2 switching between all the ports of that VLAN. Additionally, the switch exchanges ESRP packets with other switches that are in slave mode.

Pre-Master Switch Behavior

A pre-master switch is ready to transition to master, but is going through possible loop detection before changing to the master state. Upon entering the pre-master state, the switch sends ESRP packets to other switches on that same VLAN. If the switch finds itself superior to its neighbor, and successfully executes loop detection techniques, the switch transitions to master. This temporary state avoids the possibility of having simultaneous masters.

Slave Switch Behavior

If a switch is in slave mode, it exchanges ESRP packets with other switches on that same VLAN. When a switch is in slave mode, it does not perform Layer 3 routing or Layer 2 switching services for the VLAN. From a Layer 3 routing protocol perspective (for example, RIP or OSPF), when in slave mode for the VLAN, the switch marks the router interface associated with that VLAN as down. From a Layer 2 switching perspective, no forwarding occurs between the member ports of the VLAN; this prevents loops and maintains redundancy.

If you configure the switch to use the optional ESRP HA configuration, the switch continues Layer 2 forwarding to the master. For more information, see [“ESRP Host Attach” on page 1089](#).

Neutral Switch Behavior

The neutral state is the initial state entered into by the switch. In a neutral state, the switch waits for ESRP to initialize and run. A neutral switch does not participate in ESRP elections. If the switch leaves the neutral state, it enters the slave state.

Electing the Master Switch

A new master can be elected in one of the following ways:

- A communicated parameter change
- Loss of communication between master and slave(s)

If a parameter determines the master changes (for example, link loss or priority change), the election of the new master typically occurs within one second. A parameter change triggers a handshake between the routers. As long as both routers agree upon the state transition, new master election is immediate.

If a switch in slave mode loses its connection with the master, a new election occurs (using the same precedence order indicated [on page 1067](#) or using a configured precedence order described in “[ESRP Election Algorithms](#)” [on page 1070](#)). The new election typically takes place in three times the defined timer cycle (8 seconds by default).

Before the switch transitions to the master state, it enters a temporary pre-master state. While in the pre-master state, the switch sends ESRP PDUs until the pre-master state timeout expires. Depending upon the election algorithm, the switch may then enter the master or slave state. Traffic is unaffected by the pre-master state because the master continues to operate normally. The pre-master state avoids the possibility of having simultaneous masters.

You can configure the pre-master state timeout using the following command:

```
configure esrp <esrpDomain> timer premaster <seconds>
```



CAUTION

Configure the pre-master state timeout only with guidance from Extreme Networks personnel. Misconfiguration can severely degrade the performance of ESRP and your switch.

ESRP Failover Time

ESRP Failover time is largely determined by the following factors:

- ESRP hello timer setting.
- ESRP neighbor timer setting.
- The routing protocol being used for interrouter connectivity if Layer 3 redundancy is used; OSPF failover time is faster than RIP failover time.

The failover time associated with the ESRP protocol depends on the timer setting and the nature of the failure. The default hello timer setting is 2 seconds; the range is 2 to 1024 seconds. The default neighbor timer setting is 8 seconds; the range is 3*hello to 1024 seconds. The failover time depends on the type of event that caused ESRP to failover. In most cases, a non-hardware failover is less than 1 second, and a hardware failover is 8 seconds.

If routing is configured, the failover of the particular routing protocol (such as RIP V1, RIP V2, or OSPF) is added to the failover time associated with ESRP.

If you use OSPF, make your OSPF configuration passive. A passive configuration acts as a stub area and helps decrease the time it takes for recalculating the network. A passive configuration also maintains a stable OSPF core.

For more information about the ESRP timers and configuring the ESRP timers, see the *ExtremeXOS Command Reference Guide*.

ESRP Election Algorithms

You configure the switch to use one of 15 different election algorithms to select the ESRP master. ESRP uses the default election policy for extended mode. If you have an ESRP domain operating in standard mode, the domain ignores the sticky and weight algorithms.

To change the election algorithm, you must first disable the ESRP domain and then configure the new election algorithm. If you attempt to change the election algorithm without disabling the domain first, an error message appears.

To disable the ESRP domain, use the following command:

```
disable esrp [<esrpDomain>]
```

To modify the election algorithm, use the following command:

```
configure esrp <esrpDomain> add elrp-poll ports [<ports> | all]
```

If you attempt to use an election algorithm not supported by the switch, an error message similar to the following appears:

```
ERROR: Specified election-policy is not supported!
```

Supported Policies:

1. sticky > ports > weight > track > priority > mac
2. ports > track > priority
3. sticky > ports > track > priority
4. ports > track > priority > mac
5. sticky > ports > track > priority > mac
6. priority > mac
7. sticky > priority > mac
8. priority > ports > track > mac
9. sticky > priority > ports > track > mac
10. priority > track > ports > mac
11. sticky > priority > track > ports > mac
12. track > ports > priority
13. sticky > track > ports > priority
14. track > ports > priority > mac
15. sticky > track > ports > priority > mac

Table 110 describes the ESRP election algorithms. Each algorithm considers the election factors in a different order of precedence. The election algorithms that use sticky and weight are only available in extended mode.

Table 110: ESRP Election Algorithms

Election Algorithm	Description
ports > track > priority	Specifies that this ESRP domain should consider election factors in the following order: Active ports, tracking information, ESRP priority.
ports > track > priority > mac	Specifies that this ESRP domain should consider election factors in the following order: Active ports, tracking information, ESRP priority, MAC address. NOTE: This is the default election algorithm for standard mode.
priority > mac	Specifies that this ESRP domain should consider election factors in the following order: ESRP priority, MAC address.
priority > ports > track > mac	Specifies that this ESRP domain should consider election factors in the following order: ESRP priority, active ports, tracking information, MAC address.

Table 110: ESRP Election Algorithms (Continued)

Election Algorithm	Description
priority > track > ports > mac	Specifies that this ESRP domain should consider election factors in the following order: ESRP priority, tracking information, active ports, MAC address.
sticky > ports > track > priority	Specifies that this ESRP domain should consider election factors in the following order: Stickiness, active ports, tracking information, ESRP priority.
sticky > ports > track > priority > mac	Specifies that this ESRP domain should consider election factors in the following order: Stickiness, active ports, tracking information, ESRP priority, MAC address.
sticky > ports > weight > track > priority > mac	Specifies that this ESRP domain should consider election factors in the following order: Stickiness, active ports, port weight, tracking information, ESRP priority, MAC address. This is the default election algorithm for extended mode.
sticky > priority > ports > track > mac	Specifies that this ESRP domain should consider election factors in the following order: Stickiness, ESRP priority, active ports, tracking information, MAC address.
sticky > priority > track > ports > mac	Specifies that this ESRP domain should consider election factors in the following order: Stickiness, ESRP priority, tracking information, active ports, MAC address.
sticky > priority > mac	Specifies that this ESRP domain should consider election factors in the following order: Stickiness, ESRP priority, MAC address.
sticky > track > ports > priority	Specifies that this ESRP domain should consider election factors in the following order: Stickiness, tracking information, active ports, ESRP priority.
sticky > track > ports > priority > mac	Specifies that this ESRP domain should consider election factors in the following order: Stickiness, tracking information, active ports, ESRP priority, MAC address.
track > ports > priority	Specifies that this ESRP domain should consider election factors in the following order: Tracking information, active ports, ESRP priority.
track > ports > priority > mac	Specifies that this ESRP domain should consider election factors in the following order: Tracking information, active ports, ESRP priority, MAC address.

**CAUTION**

All switches in the ESRP network must use the same election algorithm, otherwise loss of connectivity, broadcast storms, or other unpredictable behavior may occur.

**NOTE**

If you have a network that contains a combination of switches running ExtremeXOS software and ExtremeWare, only the `ports-track-priority-mac` election algorithm is compatible with ExtremeWare releases before version 6.0.

ESRP Domains

ESRP domains allow you to configure multiple VLANs under the control of a single instance of the ESRP protocol. By grouping multiple VLANs under one ESRP domain, the ESRP protocol can scale to

provide protection to large numbers of VLANs. All VLANs within an ESRP domain simultaneously share the same active and standby router and failover router, as long as one port of each member VLAN belongs to the domain master.

Depending on the election policy used, when a port in a member VLAN belongs to the domain master, the member VLAN ports are considered when determining the ESRP master. You can configure a maximum of 64 ESRP domains in a network.

If you disable an ESRP domain, the switch notifies its neighbor that the ESRP domain is going down, and the neighbor clears its neighbor table. If the master switch receives this information, it enters the neutral state to prevent a network loop. If the slave switch receives this information, it enters the neutral state.

ESRP packets do not identify themselves to which domain they belong; you either configure a domain ID or the ESRP domain uses the 802.1Q tag (VLANid) of the master VLAN. A domain ID in the packet clearly classifies the packet, associates a received ESRP PDU to a specific ESRP domain, and tells the receiving port where the packet came from.

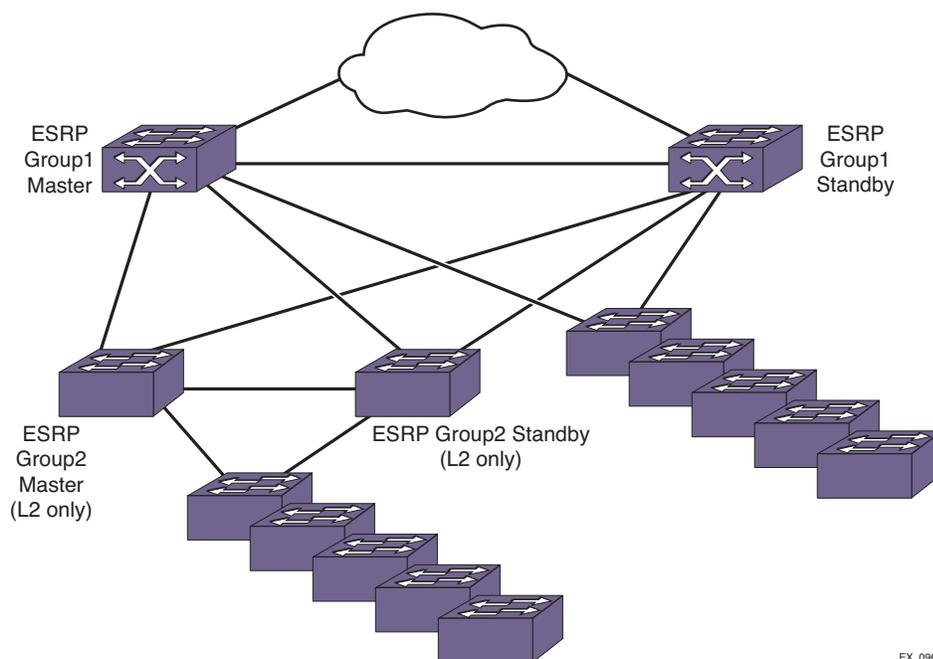
ESRP Groups

ExtremeXOS software supports running multiple instances of ESRP within the same VLAN or broadcast domain. This functionality is called an ESRP group. Although other uses exist, the most typical application for multiple ESRP groups is when two or more sets of ESRP switches are providing fast-failover protection within a subnet.

A maximum of seven distinct ESRP groups can be supported on a single ESRP switch, and a maximum of seven ESRP groups can be defined within the same network broadcast domain. You can configure a maximum of 32 ESRP groups in a network.

For example, two ESRP switches provide Layer 2/Layer 3 connectivity and redundancy for the subnet, while another two ESRP switches provide Layer 2 connectivity and redundancy for a portion of the same subnet. [Figure 163](#) shows ESRP groups.

Figure 163: ESRP Groups



EX_096

An additional use for ESRP groups is ESRP HA, described [on page 1089](#).

ESRP Extended Mode Features

The ESRP extended mode is enabled by default and provides the maximum ESRP feature set. You can use ESRP extended mode only when all switches that participate in ESRP are running ExtremeXOS software.



NOTE

If you want the ESRP feature on a switch running ExtremeXOS software to interoperate with a switch running ExtremeWare software, you must configure ESRP in the ExtremeXOS software for ESRP standard mode as described in [“Configuring Interoperability with ExtremeWare” on page 1081](#).

The following list describes the ESRP extended mode features that are not available in standard mode:

- Handshaking

In standard mode, events such as link flapping cause the ESRP master switch to generate a large number of packets and to increase processing time.

To prevent this, extended mode supports handshaking. Handshaking occurs when a switch requests a state change, forces its neighbor to acknowledge the change, and the neighbor sends an acknowledgement to the requesting switch. For example, if a slave switch wants to become the master, it enters the pre-master state, notifies the neighbor switch, and forces the neighbor to acknowledge the change. The neighbor then sends an acknowledgement back to the slave switch. While the requesting switch waits for the acknowledgements, future updates are suppressed to make sure the neighbor does not act on incorrect data.

- Stickiness

In standard mode, if an event causes the ESRP master switch to fail over to the slave, it becomes the new master. If another event occurs, the new master switch returns to the slave and you have experienced two network interruptions.

To prevent this, extended mode supports the sticky election metric. The default election algorithm uses the sticky metric. For example, if an event causes the ESRP master switch to fail over to the slave, it becomes the new master and has a higher sticky value. If another event occurs, for example adding active ports to the slave, the new master does not fail back to the original master even if the slave has more active ports. After sticky is set on the master, regardless of changes to its neighbor's election algorithm, the new master retains its position. Sticky algorithms provide for fewer network interruptions than non-sticky algorithms. Sticky is set only on the master switch.

- Port weight

In standard mode, the port count calculation does not take into account the available bandwidth of the ports. For example, a switch with a one Gigabit Ethernet uplink may be unable to become master because another switch has a load-shared group of four fast Ethernet links. The active port count calculation considers only the number of active ports, not the bandwidth of those ports.

In extended mode, the active port count calculation considers the number of active ports and the port weight configuration considers the bandwidth of those ports. You enable port weight only on the load-shared master port.

- Domain ID

In standard mode, ESRP packets do not contain domain information; therefore, the only information about the packet comes from the receiving port.

The concept of domain ID is applicable only to extended mode. A domain ID in the packet clearly classifies the packet, associates a received ESRP PDU to a specific ESRP domain, and tells the receiving port where the packet came from. In extended mode, you must have a domain ID for each ESRP domain. Each switch participating in ESRP for a particular domain must have the same domain ID configured.

The ESRP domain ID is determined from one of the following user-configured parameters:

- ESRP domain number created with the `configure esrp <esrpDomain> domain-id <number>` command
- 802.1Q tag (VLANid) of the tagged master VLAN

- Hello messages

In standard mode, both the master switch and slave switch send periodic ESRP hello messages. This causes an increase in packet processing by both the master and slave.

In extended mode, the master switch sends periodic ESRP hello messages. This reduces the amount of packet processing, increases the amount of available link bandwidth, and does not impact communicating state changes between switches.

**NOTE**

If a switch running ExtremeXOS software detects a neighbor switch that is running ExtremeWare, the ExtremeXOS switch toggles to standard mode, and the configured mode of operation remains as extended. For more information, see [“ESRP Automatic Toggle Feature” on page 1074](#).

- ESRP Automatic Toggle Feature

ESRP includes an automatic toggle feature, which toggles to the same mode of operation as an ESRP neighbor. For example, if an ExtremeXOS switch is operating in ESRP extended mode and detects a neighbor switch that is running ExtremeWare, the ExtremeXOS switch automatically changes to

standard mode for that domain. This action causes the switch to enter the neutral state and re-elect the ESRP master.

**NOTE**

The automatic toggle feature toggles the ESRP operational mode, not the configured mode. If the switch is configured for ESRP extended mode and the switch toggles to standard mode, the switch enters extended mode the next time the switch boots.

Linking ESRP Switches

When considering system design using ESRP, Extreme Networks recommends using a direct link. Direct links between ESRP switches are useful under the following conditions:

- A direct link can provide a more direct routed path, if the ESRP switches are routing and supporting multiple VLANs where the master/slave configuration is split such that one switch is master for some VLANs and a second switch is master for other VLANs. The direct link can contain a unique router-to-router VLAN/subnet, so that the most direct routed path between two VLANs with different master switches uses a direct link, instead of forwarding traffic through another set of connected routers.
- A direct link can be used as a highly reliable method to exchange ESRP hello messages, so that the possibility of having multiple masters for the same VLAN is lessened if all downstream Layer 2 switches fail.
- A direct link is necessary for the ESRP host attach (HA) option. The direct link is used to provide Layer 2 forwarding services through an ESRP slave switch.

Direct links may contain a router-to-router VLAN, along with other VLANs participating in an ESRP domain. If multiple VLANs are used on the direct links, use 802.1Q tagging. The direct links may be aggregated into a load-shared group, if desired. If multiple ESRP domains share a host port, each VLAN must be in a different ESRP group.

ESRP and Hitless Failover

**NOTE**

This section applies to Modular Switches and SummitStack only.

When you install two Management Switch Fabric Modules (MSMs) or Management Modules (MMs) in a BlackDiamond chassis, one MSM/MM (node) assumes the role of primary and the other node assumes the role of backup node. The primary node executes the switch's management functions, and the backup node acts in a standby role. Hitless failover transfers switch management control from the primary node to the backup node and maintains the state of ESRP. The ESRP extended version supports hitless failover.

For hitless failover support, ESRP switches and the primary and backup nodes must run a version of ExtremeXOS software that supports hitless failover and operate in ESRP extended mode.

**NOTE**

Not all platforms support hitless failover in the same software release. To verify if the software version you are running supports hitless failover, see [Table 15 in Chapter 2, “Managing the Switch.”](#) For more information about protocol, platform, and MSM/MM support for hitless failover, see [“Understanding Hitless Failover Support—Modular Switches and SummitStack Only” in Chapter 2, “Managing the Switch.”](#)

The ESRP domain on the primary node is active and participates in the ESRP protocol. The ESRP domain on the backup node is in the neutral state listening for configuration changes, tracking failures, and checkpointing messages and link state events. When you initiate node failover, the master ESRP switch notifies its neighbor ESRP switch about the failover. After the neighbor receives information from the master switch, the neighbor remains in its current state and waits for the failover to occur. After the failover from the primary node to the backup node is complete, the master ESRP switch notifies the neighbor so the neighbor can relinquish its current state.

**NOTE**

Before initiating failover, review the section [“Synchronizing Nodes—Modular Switches and SummitStack Only” on page 1500](#) to confirm that the primary and backup nodes are running software that supports the `synchronize` command.

To initiate hitless failover on a network that uses ESRP:

- 1 Confirm that the primary and backup nodes are synchronized and have identical software and switch configurations using the `show switch {detail}` command. The output displays the status of the nodes, with the primary node showing `MASTER` and the backup node showing `BACKUP (InSync)`.
 - If the primary and backup nodes are not synchronized and both nodes are running a version of ExtremeXOS software that supports synchronization, proceed to step 2.
 - If the primary and backup nodes are synchronized, proceed to step 3.
- 2 If the primary and backup nodes are not synchronized, use the `synchronize` command to replicate all saved images and configurations from the primary to the backup. After you confirm the MSMs/MMs are synchronized, proceed to step 3.
- 3 If the primary and backup nodes are synchronized, use the `run failover` (formerly `run msm-failover`) command to initiate failover.

For more detailed information about verifying the status of the nodes and system redundancy, see [“Understanding System Redundancy—Modular Switches and SummitStack Only” on page 81](#). For more information about hitless failover, see [“Understanding Hitless Failover Support—Modular Switches and SummitStack Only” on page 85](#).

ESRP-Aware Switches

Extreme Networks switches that are not actively participating in ESRP but are connected on a network that has other Extreme Networks switches running ESRP are *ESRP-aware*. When ESRP-aware switches are attached to ESRP-enabled switches, the ESRP-aware switches reliably perform failover and failback scenarios in the prescribed recovery times.

If Extreme Networks switches running ESRP are connected to Layer 2 switches that are manufactured by third-party vendors, the failover times for traffic local to that segment may appear longer, depending

on the application involved and the FDB timer used by the other vendor's Layer 2 switch. ESRP can be used with Layer 2 switches from other vendors, but the recovery times vary.

The VLANs associated with the ports connecting an ESRP-aware switch to an ESRP-enabled switch must be configured using an 802.1Q tag on the connecting port; or, if only a single VLAN is involved, as untagged using the protocol filter `any`. ESRP does not function correctly if the ESRP-aware switch interconnection port is configured for a protocol-sensitive VLAN using untagged traffic. You can also use port restart in this scenario. For more information about port restart, see [“ESRP Port Restart” on page 1088](#).

The following sections provide information on managing ESRP-aware switches:

- [Configuring ESRP-Aware Switches on page 1080](#)
- [ESRP Configuration Examples on page 1092](#)

ExtremeWare Compatibility

The ExtremeXOS software has two modes of ESRP operation: standard and extended. Select standard ESRP if your network contains some switches running ExtremeWare, others running ExtremeXOS software, and a combination of those switches participating in ESRP. Standard ESRP is backward compatible with and supports the ESRP functionality of ExtremeWare.

Select extended ESRP if your network contains switches running *only* ExtremeXOS software. Extended mode ESRP supports and is compatible with switches running ExtremeXOS software. By default, the ExtremeXOS software operates in extended mode.

In addition to the modes of operation, ESRP has an auto toggle feature. Depending on the mode of operation configured on the neighbor switch, the mode of operation at this end will toggle to the same mode of operation as the neighbor.

For more detailed information about the ESRP modes of operation, see [“Configuring Interoperability with ExtremeWare” on page 1081](#).

Configuring ESRP

The following sections describe how to configure VRRP:

- [Guidelines on page 1078](#)
- [Configuration Overview on page 1078](#)
- [Creating and Deleting an ESRP Domain on page 1079](#)
- [Configuring the ESRP Domain ID on page 1079](#)
- [Adding and Deleting a Master VLAN on page 1079](#)
- [Adding and Deleting a Member VLAN on page 1080](#)
- [Enabling and Disabling an ESRP Domain on page 1080](#)
- [Configuring ESRP-Aware Switches on page 1080](#)
- [Configuring Interoperability with ExtremeWare on page 1081](#)

Guidelines

To participate in ESRP, the following must be true:

- A VLAN can belong to only one ESRP domain.
- The IP address for the VLANs participating in an ESRP domain must be identical.
- For operation over IPv6, both an IPv6 and an IPv4 address must be present on the master VLAN for every participating router.
- All switches in the ESRP network must use the same election algorithm, otherwise loss of connectivity, broadcast storms, or other unpredictable behavior may occur.
- If you have an untagged master VLAN, you must specify an ESRP domain ID. The domain ID must be *identical* on all switches participating in ESRP for that particular domain.
- If you have a tagged master VLAN, ESRP uses the 802.1Q tag (VLANid) of the master VLAN for the ESRP domain ID. If you do not use the VLANid as the domain ID, you must specify a different domain ID. As previously described, the domain ID must be identical on all switches participating in ESRP for that particular domain.



NOTE

If you configure the Open Shortest Path First (OSPF) routing protocol and ESRP, you must manually configure an OSPF router identifier (ID). Be sure that you configure a unique OSPF router ID on each switch running ESRP. For more information on configuring OSPF, see [Chapter 35, “OSPF”](#).

Extreme Networks recommends that all switches participating in ESRP run the same version of ExtremeXOS software.

Configuration Overview

The following procedure can be used to configure a simple ESRP topology:

- 1 Create and configure a VLAN that will become the master VLAN. (See [Chapter 12, “VLANs.”](#))
- 2 As needed, create and configure the VLANs that will become the member VLANs. (See [Chapter 12, “VLANs.”](#))
- 3 Create the ESRP domain as described in [“Creating and Deleting an ESRP Domain” on page 1079](#).
- 4 If your configuration requires an ESRP domain ID, configure it as described in [“Configuring the ESRP Domain ID” on page 1079](#).
- 5 Add the master VLAN to the ESRP domain as described in [“Adding and Deleting a Master VLAN” on page 1079](#).
- 6 If your configuration requires member VLANs, add the member VLANs to the ESRP domain as described in [“Adding and Deleting a Member VLAN” on page 1080](#).
- 7 Enable ESRP for the specified ESRP domain as described in [“Enabling and Disabling an ESRP Domain” on page 1080](#).

You can also configure other ESRP domain parameters, including ESRP:

- Mode of operation as described in [“Configuring Interoperability with ExtremeWare” on page 1081](#).
- Timers as described in the *ExtremeXOS Command Reference Guide*.
- Election algorithms as described in [“ESRP Election Algorithms” on page 1070](#).
- Tracking as described in [“ESRP Tracking” on page 1085](#).

- Port restart as described in “[ESRP Port Restart](#)” on page 1088.
- Host attach as described in “[ESRP Host Attach](#)” on page 1089.
- Groups as described in “[ESRP Groups](#)” on page 1072.

For more detailed information about all of the commands used to create, configure, enable, and disable an ESRP domain, refer to the *ExtremeXOS Command Reference Guide*.

Creating and Deleting an ESRP Domain

You specify a unique ESRP domain name to identify each ESRP domain in your network.

To create an ESRP domain, use the following command:

```
create esrp <esrp_domain> {type [vpls-redundancy | standard]}
```

The `esrpDomain` parameter is a character string of up to 32 characters that identifies the ESRP domain to be created.



NOTE

If you use the same name across categories (for example, STPD and ESRP names) Extreme Networks recommends that you specify the appropriate keyword as well as the actual name. If you do not specify the keyword, the switch may display an error message.

To delete an ESRP domain, use the following command:

```
delete esrp <esrpDomain>
```

Configuring the ESRP Domain ID

If you choose not use the 802.1Q tag (VLANid) of the master VLAN, or you have an untagged master VLAN, you must create a domain ID before you can enable the ESRP domain. For more information about ESRP domains and the ESRP domain ID, see “[ESRP Domains](#)” on page 1071.

To configure an ESRP domain ID, use the following command:

```
configure esrp <esrpDomain> domain-id <number>
```

The `number` parameter specifies the number of the domain ID. The user-configured ID range is 4096 through 65,535.

Adding and Deleting a Master VLAN

The master VLAN is the VLAN on the ESRP domain that exchanges ESRP PDUs and data between a pair of ESRP-enabled devices. You must configure one master VLAN for each ESRP domain, and a master VLAN can belong to only one ESRP domain.

To add a master VLAN to an ESRP domain, use the following command:

```
configure esrp <esrpDomain> add master <vlan_name>
```

The `esrpDomain` parameter specifies the name of the ESRP domain, and the `vlan_name` parameter specifies the name of the master VLAN.

To delete a master VLAN, you must first disable the ESRP domain before removing the master VLAN using the `disable esrp {<esrpDomain>}` command.

To delete a master VLAN from an ESRP domain, use the following command:

```
configure esrp <esrpDomain> delete master <vlan_name>
```

Adding and Deleting a Member VLAN

The member VLAN can belong to only one ESRP domain, and you configure zero or more member VLANs for each ESRP domain. The state of the ESRP device determines whether the member VLAN is in the forwarding or blocking state.

To add a member VLAN to an ESRP domain, use the following command:

```
configure esrp <esrpDomain> add member <vlan_name>
```

The `esrpDomain` parameter specifies the name of the ESRP domain, and the `vlan_name` parameter specifies the name of the member VLAN.

To delete a member VLAN from an ESRP domain, use the following command:

```
configure esrp <esrpDomain> delete member <vlan_name>
```

Enabling and Disabling an ESRP Domain

To enable a specific ESRP domain, use the following command:

```
enable esrp <esrpDomain>
```

To disable a specific ESRP domain, use the following command:

```
disable esrp {<esrpDomain>}
```

Configuring ESRP-Aware Switches

For an Extreme Networks switch to be ESRP-aware, you must create an ESRP domain on the aware switch, add a master VLAN to that ESRP domain, add a member VLAN to that ESRP domain if configured, and configure a domain ID if necessary.

To participate as an ESRP-aware switch, the following must be true:

- The ESRP domain name must *identical* on all switches (ESRP-enabled and ESRP-aware) participating in ESRP for that particular domain.
- The master VLAN name and IP address must be *identical* on all switches (ESRP-enabled and ESRP-aware) participating in ESRP for that particular domain.
- If configured, the member VLAN name and IP address must be *identical* on all switches (ESRP-enabled and ESRP-aware) participating in ESRP for that particular domain.
- The domain ID must be *identical* on all switches (ESRP-enabled or ESRP-aware) participating in ESRP for that particular domain.
 - If you have an untagged master VLAN, you must specify an ESRP domain ID.
 - If you have a tagged master VLAN, ESRP uses the 802.1Q tag (VLANid) of the master VLAN for the ESRP domain ID. If you do not use the VLANid as the domain ID, you must specify a different domain ID.

**NOTE**

Before you begin, make a note of the ESRP domain parameters on the ESRP-enabled switch. That way you can easily refer to your notes while creating the ESRP domain on the ESRP-aware switch.

To configure an ESRP-aware switch:

- 1 Create an ESRP domain using the `create esrp <esrp_domain> {type [vpls-redundancy | standard]}` command.

For complete information about software licensing for this feature, see [Appendix A, “Feature License Requirements.”](#)

- 2 Add a master VLAN to your ESRP domain using the `configure esrp <esrpDomain> add master <vlan_name>` command.
- 3 If configured, add the member VLANs to your ESRP domain using the `configure esrp <esrpDomain> add member <vlan_name>` command.
- 4 If necessary, configure a domain ID for the ESRP domain using the `configure esrp <esrpDomain> domain-id <number>` command.

Configuring Interoperability with ExtremeWare

The ESRP feature in ExtremeXOS software supports interoperability with switches that are running ExtremeWare software. If you want the ESRP feature on an ExtremeXOS switch to interoperate with an ExtremeWare switch, you must configure ESRP in the ExtremeXOS software for ESRP standard mode using the following command:

```
configure esrp mode [extended | standard]
```

**NOTE**

By default, the ESRP feature operates in extended mode. ESRP extended mode provides additional features that are not available in standard mode. Use ESRP extended mode only if all switches that participate in ESRP are running ExtremeXOS software. For more information on additional features supported in extended mode, see [“ESRP Extended Mode Features” on page 1073.](#)

**NOTE**

ExtremeWare switches forward only those ESRP hello messages that apply to the ESRP group to which the switch belongs. ExtremeWare switches do not forward ESRP hello messages for other ESRP groups in the same VLAN. This limitation does not apply to ExtremeXOS switches operating in standard mode.

Operation with Other ExtremeXOS Features

The following sections provide additional guidelines for using ESRP with other features:

- [ESRP and IP Multinetting on page 1082](#)
- [ESRP and STP on page 1082](#)
- [ESRP and VRRP on page 1082](#)

- [ESRP Groups and Host Attach on page 1082](#)
- [Port Configurations and ESRP on page 1082](#)

ESRP and IP Multinetting

When configuring ESRP and IP multinetting on the same switch, the same set of IP addresses must be configured for all involved VLANs.

ESRP and STP

A switch running ESRP should not simultaneously participate in STP for the same VLAN(s). Other switches in the VLAN being protected by ESRP may run STP; the switch running ESRP forwards, but does not filter, STP BPDUs. Therefore, you can combine ESRP and STP on a network and a VLAN, but you must do so on separate devices. You should be careful to maintain ESRP connectivity between ESRP master and slave switches when you design a network that uses ESRP and STP.

ESRP and VRRP

Do not configure ESRP and VRRP on the same VLAN or port. This configuration is not allowed or supported.

ESRP Groups and Host Attach

ESRP domains that share ESRP HA ports must be members of different ESRP groups.

Port Configurations and ESRP

The following ports cannot be part of a VLAN that participates in an ESRP domain:

- A mirroring target port
- A software-controlled redundant port
- A Netlogin port

In addition, the following ESRP ports cannot be a mirroring, software-controlled redundant port, or Netlogin port:

- Host Attach port.
- Don't-count port. (This port has a port weight of 0.)
- Restart port.

Using ELRP with ESRP

Extreme Loop Recovery Protocol (ELRP) is a feature of ExtremeXOS software that allows you to prevent, detect, and recover from Layer 2 loops in the network. You can use ELRP with other protocols such as ESRP.

**NOTE**

The ExtremeXOS software does not support ELRP and Network Login on the same port. When used on a VPLS service VLAN, ELRP does not detect loops involving the VPLS pseudo wires.

For more information about standalone ELRP, see [“Using ELRP to Perform Loop Tests” on page 1530](#).

With ELRP, each switch, except for the sender, treats the ELRP protocol data unit (PDU) as a Layer 2 multicast packet. The sender uses the source and destination MAC addresses to identify the packet it sends and receives. When the sender receives its original packet back, that triggers loop detection and prevention. After a loop is detected, the loop recovery agent is notified of the event and takes the necessary actions to recover from the loop. ELRP operates only on the sending switch; therefore, ELRP operates transparently across the network.

How a loop recovers is dependent upon the protocol that uses the loop detection services provided by ELRP. If you are using ELRP in an ESRP environment, ESRP may recover by transitioning the ESRP domain from master to slave. The following sections describe how ESRP uses ELRP to recover from a loop and the switch behavior:

- [Using ELRP with ESRP to Recover Loops on page 1083](#)
- [Configuring ELRP on page 1084](#)
- [Displaying ELRP Information on page 1085](#)

Using ELRP with ESRP to Recover Loops

ELRP sends loop-detect packets to notify ESRP about loops in the network. In an ESRP environment, when the current master goes down, one of the slaves becomes the master and continues to forward Layer 2 and Layer 3 traffic for the ESRP domain. If a situation occurs when a slave incorrectly concludes that the master is down, the slave incorrectly assumes the role of master. This introduces more than one master on the ESRP domain which causes temporary loops and disruption in the network.

ELRP on an ESRP Pre-Master Switch. A pre-master switch is an ESRP switch that is ready to transition to master but is going through possible loop detection. A pre-master periodically sends out ELRP loop-detect packets (ELRP PDUs) for a specified number of times and waits to make sure that none of the sent ELRP PDUs are received. Transition to master occurs only after this additional check is completed. If any of the ELRP PDUs are received, the switch transitions from pre-master to slave state. You configure pre-master ELRP loop detection on a per ESRP domain basis.

ELRP on an ESRP Master Switch . A master switch is an ESRP switch that sends ELRP PDUs on its ESRP domain ports. If the master switch receives an ELRP PDU that it sent, the master transitions to the slave. While in the slave state, the switch transitions to the pre-master rate and periodically checks for loops before transitioning to the master. The pre-master process is described in [“ELRP on an ESRP Pre-Master Switch” on page 1083](#). You configure the master ELRP loop detection on a per ESRP domain basis.

Configuring ELRP

By default, ELRP is disabled. The following sections describe the commands used to configure ELRP for use with ESRP:

- [Configuring Pre-Master Polling on page 1084](#)
- [Configuring Master Polling on page 1084](#)
- [Configuring Ports on page 1084](#)



NOTE

When used on a VPLS service VLAN, ELRP does not detect loops involving the VPLS pseudo wires.

Configuring Pre-Master Polling. If you enable the use of ELRP by ESRP in the pre-master state, ESRP requests ELRP packets sent to ensure that there is no loop in the network before changing to the master state. If no packets are received, there is no loop in the network. By default, the use of ELRP by ESRP in the pre-master state is disabled.

To enable the use of ELRP by ESRP in the pre-master state on a per-ESRP domain basis, and to configure how often and how many ELRP PDUs are sent in the pre-master state, use the following command:

```
configure esrp <esrpDomain> elrp-premaster-poll enable {count <count> | interval <interval>}
```

To disable the use of ELRP by ESRP in the pre-master state, use the following command:

```
configure esrp <esrpDomain> elrp-premaster-poll disable
```

Configuring Master Polling. If you enable the use of ELRP by ESRP in the master state, ESRP requests that ELRP packets are periodically sent to ensure that there is no loop in the network while ESRP is in the master state. By default, the use of ELRP by ESRP in the master state is disabled.

To enable the use of ELRP by ESRP in the master state on a per-ESRP domain basis, and to configure how often the master checks for loops in the network, use the following command:

```
configure esrp <esrpDomain> elrp-master-poll enable {interval <interval>}
```

To disable the use of ELRP by ESRP in the master state, use the following command:

```
configure esrp <esrpDomain> elrp-master-poll disable
```

Configuring Ports . You can configure one or more ports of an ESRP domain where ELRP packet transmission is requested by ESRP. This allows the ports in your network that might experience loops, such as ports that connect to the master, slave, or ESRP-aware switches, to receive ELRP packets. You do not need to send ELRP packets to host ports.



NOTE

The ExtremeXOS software does not support ELRP and Network Login on the same port.

By default, all ports of the ESRP domain have ELRP transmission enabled on the ports.

If you change your network configuration, and a port no longer connects to a master, slave, or ESRP-aware switch, you can disable ELRP transmission on that port. To disable ELRP transmission, use the following command:

```
configure esrp <esrpDomain> delete elrp-poll ports [<ports> | all]
```

To enable ELRP transmission on a port, use the following command:

```
configure esrp <esrpDomain> add elrp-poll ports [<ports> | all]
```

Displaying ELRP Information

To display summary ELRP information, use the following command:

```
show elrp
```

In addition to displaying the enabled/disabled state of ELRP, the command displays the total number of:

- Clients registered with ELRP
- ELRP packets transmitted
- ELRP packets received

For more information about the output associated with the `show elrp` command, see the *ExtremeXOS Command Reference Guide*.

Advanced ESRP Features

This section describes the following advanced ESRP features:

- [ESRP Tracking on page 1085](#)
- [ESRP Port Restart on page 1088](#)
- [ESRP Host Attach on page 1089](#)
- [ESRP Port Weight and Don't Count on page 1090](#)
- [Selective Forwarding on page 1090](#)

ESRP Tracking

Tracking information is used to track various forms of connectivity from the ESRP switch to the outside world. This section describes the following ESRP tracking options:

- [ESRP Environment Tracking on page 1086](#)
- [ESRP VLAN Tracking on page 1086](#)
- [ESRP Unicast Route Table Tracking on page 1086](#)
- [ESRP Ping Tracking on page 1087](#)
- [Displaying ESRP Tracking Information on page 1087](#)

ESRP Environment Tracking

You can configure ESRP to track hardware status. If a power supply fails, if the chassis is overheating, or if a non-fully loaded power supply is detected, the priority for the ESRP domain will change to the failover settings.



NOTE

ExtremeXOS software determines the maximum available power required for the switch by calculating the number of power supplies and the power required by the installed modules. Enabling environmental tracking on the switch without enough power budget causes tracking to fail. In this case, the tracking failure occurs by design.

To configure the failover priority for an ESRP domain:

- 1 Set the failover priority, using the following command:

```
configure esrp <esrpDomain> add track-environment failover <priority>
```

- 2 Assign the priority flag precedence over the active ports count, using the following command:

```
configure esrp <esrpDomain> election-policy [ports > track > priority | ports >
track > priority > mac | priority > mac | priority > ports > track > mac |
priority > track > ports > mac | sticky > ports > track > priority | sticky >
ports > track > priority > mac | sticky > ports > weight > track > priority >
mac | sticky > priority > mac | sticky > priority > ports > track > mac | sticky
> priority > track > ports > mac | sticky > track > ports > priority | sticky >
track > ports > priority > mac | track > ports > priority | track > ports >
priority > mac]
```

Because the priority of both ESRP domains are set to the same value, ESRP will use the active ports count to determine the master ESRP domain.

ESRP VLAN Tracking

You can configure an ESRP domain to track port connectivity to a specified VLAN as criteria for ESRP failover. The number of VLAN active ports are tracked. If the switch is no longer connected to the specified VLAN, the switch automatically relinquishes master status and remains in slave mode. You can track a maximum of one VLAN.

To add a tracked VLAN, use the following command:

```
configure esrp <esrpDomain> add track-vlan <vlan_name>
```

To delete a tracked VLAN, use the following command:

```
configure esrp <esrpDomain> delete track-vlan <vlan_name>
```

ESRP Unicast Route Table Tracking

You can configure ESRP to track specified IPv4 routes in the route table as criteria for ESRP failover. If all of the configured routes are not available within the route table, the switch automatically relinquishes master status and remains in slave mode. You can track a maximum of eight routes per route table.



NOTE

ESRP route tracking is not supported for IPv6 destinations..

To add a tracked route, use the following command:

```
configure esrp <esrpDomain> add track-iproute <ipaddress>/<masklength>
```

To delete a tracked route, use the following command:

```
configure esrp <esrpDomain> delete track-iproute <ipaddress>/<masklength>
```

ESRP Ping Tracking

You can configure ESRP to track connectivity using a simple ping to any IPv4 device. This may represent the default route of the switch, or any device meaningful to network connectivity of the master ESRP switch. The switch automatically relinquishes master status and remains in slave mode if a ping keepalive fails. You can configure a maximum of eight ping tracks.



NOTE

ESRP ping tracking is not supported for IPv6 destinations. The ESRP ping tracking option cannot be configured to ping an IP address within an ESRP VLAN subnet. It should be configured on some other normal VLAN across the router boundary.

To configure ping tracking, use the following command:

```
configure esrp <esrpDomain> add track-ping <ipaddress> frequency <seconds> miss <misses>
```

The `seconds` parameter specifies the number of seconds between ping requests. The range is 1 to 600 seconds.

The `misses` parameter specifies the number of consecutive ping failures that will initiate failover to an ESRP slave. The range is 1 to 256 pings.

To disable ping tracking, use the following command:

```
configure esrp <esrpDomain> delete track-ping <ipaddress>
```

Displaying ESRP Tracking Information

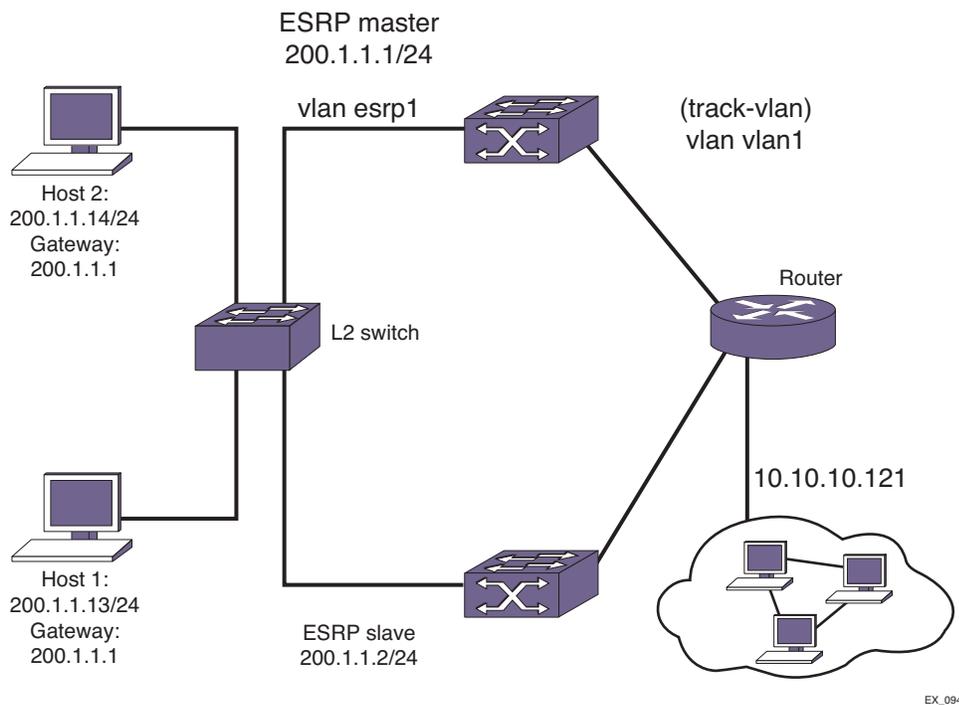
You can view the status of ESRP tracking on a per domain basis. The information displayed includes the type of tracking used by the ESRP domain and how you configured the tracking option.

To view the status of tracked devices, use the following command:

```
show esrp <name>
```

ESRP Tracking Example

Figure 164 is an example of ESRP tracking.

Figure 164: ESRP Tracking

To configure VLAN tracking, use the following command:

```
configure esrp esrp1 add track-vlan vlan1
```

Using the tracking mechanism, if VLAN1 fails, the ESRP master realizes that there is no path to the upstream router via the master switch and implements an ESRP failover to the slave switch.

To configure route table tracking, use the following command:

```
configure esrp esrp1 add track-iproute 10.10.10.0/24
```

The IPv4 route specified in this command must exist in the IP routing table. When the route is no longer available, the switch implements an ESRP failover to the slave switch.

To configure ping tracking, use the following command:

```
configure esrp esrp1 add track-ping 10.10.10.121 frequency 2 miss 2
```

The specified IPv4 address is tracked. If the fail rate is exceeded, the switch implements an ESRP failover to the slave switch.

ESRP Port Restart

You can configure ESRP to restart ports in the ESRP master domain when the downstream switch is from a third-party vendor. This action takes down and restarts the port link to clear and refresh the downstream ARP table.

To configure port restart, use the following command:

```
configure esrp ports <ports> restart
```

To disable port restart, use the following command:

```
configure esrp ports <ports> no-restart
```

If a switch becomes a slave, ESRP takes down (disconnects) the physical links of member ports that have port restart enabled. The disconnection of these ports causes downstream devices to remove the ports from their FDB tables. This feature allows you to use ESRP in networks that include equipment from other vendors. After 2 seconds, the ports re-establish connection with the ESRP switch.

To remove a port from the restart configuration, delete the port from the VLAN and re-add it.

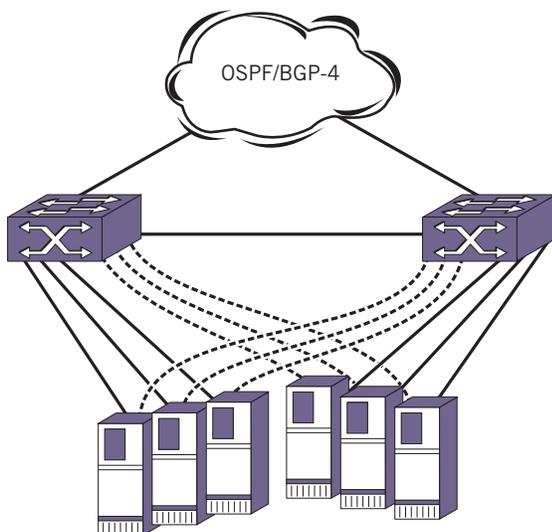
ESRP Host Attach

ESRP host attach (HA) is an optional ESRP configuration that allows you to connect active hosts directly to an ESRP master or slave switch. Normally, the Layer 2 redundancy and loop prevention capabilities of ESRP do not allow packet forwarding from the slave ESRP switch. ESRP HA allows configured ports that do not represent loops to the network to continue Layer 2 operation independent of their ESRP status.

ESRP HA is designed for redundancy for dual-homed server connections. HA allows the network to continue Layer 2 forwarding regardless of the ESRP status. Do not use ESRP HA to interconnect devices on the slave ESRP switch instead of connecting directly to the ESRP master switch.

The ESRP HA option is useful if you are using dual-homed network interface cards (NICs) for server farms, as shown in [Figure 165](#). The ESRP HA option is also useful where an unblocked Layer 2 environment is necessary to allow high-availability security.

Figure 165: ESRP Host Attach



EX_095

ESRP VLANs that share ESRP HA ports must be members of different ESRP groups. Each port can have a maximum of seven VLANs.

If you use load sharing with the ESRP HA feature, configure the load-sharing group first and then enable HA on the group.

Other applications allow lower-cost redundant routing configurations because hosts can be directly attached to the switch involved with ESRP. HA also requires at least one link between the master and the slave ESRP switch for carrying traffic and to exchange ESRP hello packets.

ESRP domains that share ESRP HA ports must be members of different ESRP groups.

**NOTE**

Do not use the ESRP HA feature with the following protocols: STP, or VRRP. A broadcast storm may occur.

To configure a port to be a host port, use the following command:

```
configure esrp ports <ports> mode [host | normal]
```

ESRP Port Weight and Don't Count

In an ESRP domain, the switch automatically calculates the port weight based on the bandwidth of the port. ESRP uses the port weight to determine the master ESRP switch.

For load-shared ports, configure the master port in the load-share group with the port weight. A load-shared port has an aggregate weight of all of its member ports. If you add or delete a load-shared port (or trunk), the master load-shared port weight is updated.

If you do not want to count host ports and normal ports as active, configure the ESRP port weight on those ports. Their weight becomes 0 and that allows the port to be part of the VLAN, but if a link failure occurs, it will not trigger a reconvergence. With this configuration, ESRP experiences fewer state changes due to frequent client activities like rebooting and unplugging laptops. This port is known as a don't-count port.

To configure the port weight on either a host attach port or a normal port, use the following command:

```
configure esrp ports <ports> weight [auto | <port-weight>]
```

Selective Forwarding

An ESRP-aware switch floods ESRP PDUs from all ports in an ESRP-aware VLAN. This flooding creates unnecessary network traffic because some ports forward ESRP PDUs to switches that are not running the same ESRP groups. You can select the ports that are appropriate for forwarding ESRP PDUs by configuring selective forwarding on an ESRP-aware VLAN and thus reduce this excess traffic. Configuring selective forwarding creates a port list of only those ports that forward to the ESRP groups that are associated with an ESRP-aware VLAN. This ESRP-aware port list is then used for forwarding ESRP PDUs.

**NOTE**

Extreme Networks recommends keeping the default settings unless you have considerable knowledge and experience with ESRP.

To configure selective forwarding, use the following command:

```
configure esrp <domain> aware add selective-forward-ports <portlist> {group <group number>}
```

When an ESRP-aware switch receives an ESRP PDU on a domain, the software looks up the group to which the PDU belongs. If the group is found, the ESRP-aware switch processes the PDU then and forwards it according to the group's specified aware selective forwarding port list. If no selective forwarding port list is configured, the switch forwards the PDU from all of the ports of the domain's master VLAN. If the group is not found, the PDU is forwarded on all ports.

When a user adds one or more ports to the ESRP-aware port list (for example, 5:1 and 6:2) that are not part of the master VLAN, the following message appears:

```
Warning: Port 5:1, 6:2 not currently a member of master vlan
```

The ports will still be added to the ESRP-aware port list; however, PDUs will not be forwarded out of those ports until they are added to the master VLAN.

To disable selective forwarding, use the following command:

```
configure esrp <domain> aware delete selective-forward-ports <all|portlist> {group <group number>}
```

Displaying Selective Forwarding Information

To display all selective forwarding information for a given domain, use the following command:

```
show esrp <domain> aware {selective-forward-ports | statistics}
```

Displaying ESRP Information

To view ESRP information, use the following command:

```
show esrp
```

Output from this command includes:

- The operational state of an ESRP domain and the state of its neighbor
- ESRP port configurations

To view more detailed information about an ESRP domain on an ESRP enabled switch or an ESRP aware switch, use the following command and specify the domain name:

```
show esrp { {name} | {type [vpls-redundancy | standard]} }
```

To view ESRP counter information for a specific domain, use the following command:

```
show esrp {<name>} counters
```

To view ESRP-aware information for a specific domain (including the group number, MAC address for the master, and the age of information) use the following command:

```
show esrp <domain> aware {selective-forward-ports | statistics}
```

ESRP Configuration Examples

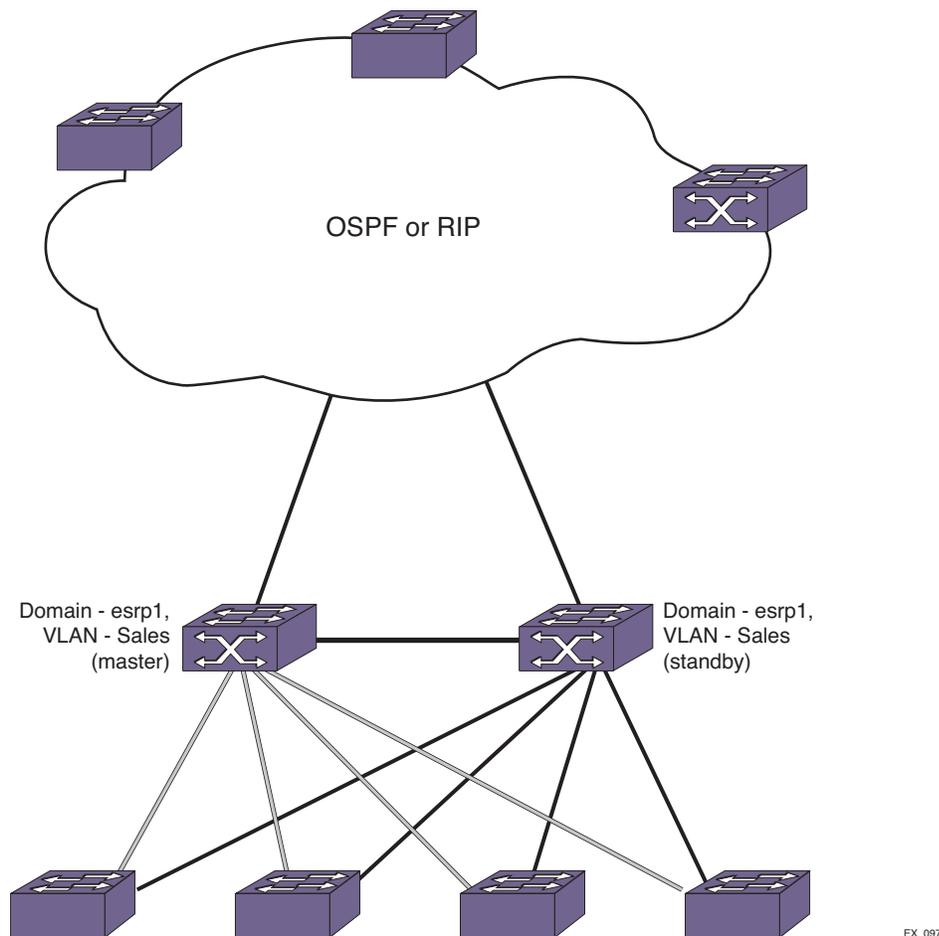
This section provides the following examples of ESRP configurations:

- [Single Domain Using Layer 2 and Layer 3 Redundancy on page 1092](#)
- [Multiple Domains Using Layer 2 and Layer 3 Redundancy on page 1093](#)
- [ESRP Over IPv6 Configuration Example on page 1095](#)

Single Domain Using Layer 2 and Layer 3 Redundancy

The example shown in [Figure 166](#) uses four Extreme Networks devices as edge switches that perform Layer 2 switching for VLAN *Sales*. The edge switches are dual-homed two switches that are configured to support ESRP domain *esrp1*. The ESRP switches perform Layer 2 switching and Layer 3 routing between the edge switches and the outside world. Each ESRP switch has the VLAN *Sales* configured using the identical IP address. The ESRP switches then connect to the routed enterprise normally, using the desired routing protocol (for example, RIP or OSPF).

Figure 166: Single ESRP Domain Using Layer 2 and Layer 3 Redundancy



EX_097

In [Figure 166](#), the ESRP master performs both Layer 2 switching and Layer 3 routing services for VLAN *Sales*. To prevent bridging loops in the VLAN, the ESRP slave performs no switching or routing for VLAN *Sales* while the ESRP master is operating.

There are four paths between each ESRP switch and the edge switches for VLAN *Sales*. All the paths are used to send ESRP packets, allowing for four redundant paths for communication. The edge switches, being ESRP-aware, allow traffic within the VLAN to failover quickly because these edge switches sense when a master/slave transition occurs and flush FDB entries associated with the uplinks to the ESRP-enabled switches.

This example assumes the following:

- ESRP election algorithm used is the default for standard mode (`ports > track > priority > mac`).
- The Inter-router backbone is running OSPF, with other routed VLANs already properly configured. Similar commands would be used to configure a switch on a network running RIP.
- Ports added to the VLAN have already been removed from VLAN *default*.
- The same IP address is specified for all VLANs participating in ESRP.
- The master is determined by the programmed MAC address of the switch because the number of active links for the VLAN and the priority are identical for both switches.



NOTE

If your network has switches running ExtremeWare and ExtremeXOS software participating in ESRP, Extreme Networks recommends that the ExtremeXOS switches operate in ESRP standard mode. To change the mode of operation, use the `configure esrp mode [extended | standard]` command.

The following commands are used to configure both ESRP switches:

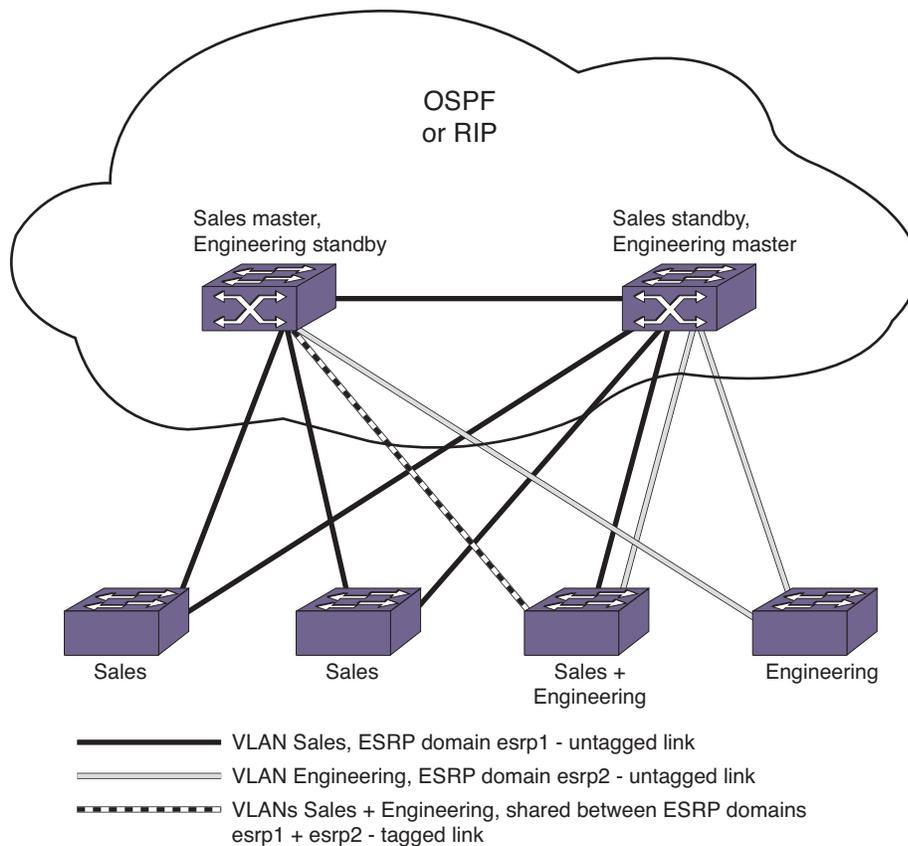
```
create vlan sales
configure vlan sales add ports 1:1-1:4
configure vlan sales ipaddress 10.1.2.3/24
enable ipforwarding

create esrp esrp1
configure esrp esrp1 domain-id 4096
configure esrp esrp1 add master sales
enable esrp esrp1

configure ospf add vlan sales area 0.0.0.0 passive
configure ospf routerid 5.5.5.5
enable ospf
```

Multiple Domains Using Layer 2 and Layer 3 Redundancy

The example shown in [Figure 167](#) illustrates an ESRP configuration that has multiple domains using Layer 2 and Layer 3 redundancy.

Figure 167: Multiple ESRP Domains Using Layer 2 and Layer 3 Redundancy

This example builds on the previous example. It has the following features:

- An additional VLAN, *Engineering*, is added that uses Layer 2 redundancy.
- The VLAN *Sales* uses three active links to each ESRP switch.
- The VLAN *Engineering* has two active links to each ESRP switch.
- One of the edge devices carries traffic for both VLANs.
- The link between the third edge device and the first ESRP switch uses 802.1Q tagging to carry traffic from both VLANs on one link. The ESRP switch counts the link active for each VLAN.
- The second ESRP switch has a separate physical port for each VLAN connected to the third edge switch.

In this example, the ESRP switches are configured such that the VLAN *Sales* normally uses the first ESRP switch and the VLAN *Engineering* normally uses the second ESRP switch. This is accomplished by manipulating the ESRP priority setting for each VLAN for the particular ESRP switch.

Configuration commands for the first ESRP switch are as follows:

```
create vlan sales
configure vlan sales tag 10
configure vlan sales add ports 1:1-1:2
configure vlan sales add ports 1:3, 1:5 tagged
configure vlan sales ipaddress 10.1.2.3/24
create vlan engineering
configure vlan engineering tag 20
configure vlan engineering add ports 1:4
```

```
configure vlan engineering add ports 1:3, 1:5 tagged
configure vlan engineering ipaddress 10.4.5.6/24
```

```
create esrp esrp1
configure esrp esrp1 domain-id 4096
configure esrp esrp1 add master sales
configure esrp esrp1 priority 5
enable esrp esrp1
```

```
create esrp esrp2
configure esrp esrp2 domain-id 4097
configure esrp esrp2 add master engineering
enable esrp esrp2
```

Configuration commands for the second ESRP switch are as follows:

```
create vlan sales
configure vlan sales tag 10
configure vlan sales add ports 1:1-1:3
configure vlan sales ipaddress 10.1.2.3/24
configure vlan sales add ports 1:5 tagged
create vlan engineering
configure vlan engineering tag 20
configure vlan engineering add ports 1:4, 2:1
configure vlan engineering ipaddress 10.4.5.6/24
configure vlan engineering add ports 1:5 tagged
```

```
create esrp esrp1
configure esrp esrp1 domain-id 4096
configure esrp 1 add master sales
enable esrp esrp1
```

```
create esrp esrp2
configure esrp esrp2 domain-id 4097
configure esrp esrp2 add master engineering
configure esrp esrp2 priority 5
enable esrp esrp2
```

ESRP Over IPv6 Configuration Example

The example shown in [Figure 167](#) illustrates an ESRP configuration that can operate over IPv6.



NOTE

To support operation over IPv6, the master VLANs configured in this example require both an IPv4 and an IPv6 address. ESRP route tracking and ESRP ping tracking are not supported for IPv6 addresses.

Configuration commands for the first ESRP switch are as follows:

```
create vlan sales
configure vlan sales tag 10
configure vlan sales add ports 1:1-1:2
configure vlan sales add ports 1:3, 1:5 tagged
configure vlan sales ipaddress 10.1.2.3/24
configure vlan sales ipaddress 2001:db8:36::1/48
```

```
create vlan engineering
configure vlan engineering tag 20
configure vlan engineering add ports 1:4
configure vlan engineering add ports 1:3, 1:5 tagged
configure vlan engineering ipaddress 10.4.5.6/24
configure vlan engineering ipaddress 2001:db8:36::2/48
create esrp esrp1
configure esrp esrp1 domain-id 4096
configure esrp esrp1 add master sales
configure esrp esrp1 priority 5
enable esrp esrp1
create esrp esrp2
configure esrp esrp2 domain-id 4097
configure esrp esrp2 add master engineering
enable esrp esrp2
```

Configuration commands for the second ESRP switch are as follows:

```
create vlan sales
configure vlan sales tag 10
configure vlan sales add ports 1:1-1:3
configure vlan sales ipaddress 10.1.2.3/24
configure vlan sales ipaddress 2001:db8:36::1/48
configure vlan sales add ports 1:5 tagged
create vlan engineering
configure vlan engineering tag 20
configure vlan engineering add ports 1:4, 2:1
configure vlan engineering ipaddress 10.4.5.6/24
configure vlan engineering ipaddress 2001:db8:36::2/48
configure vlan engineering add ports 1:5 tagged
create esrp esrp1
configure esrp esrp1 domain-id 4096
configure esrp 1 add master sales
enable esrp esrp1
create esrp esrp2
configure esrp esrp2 domain-id 4097
configure esrp esrp2 add master engineering
configure esrp esrp2 priority 5
enable esrp esrp2
```

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CHAPTER

VRRP

This chapter includes the following sections:

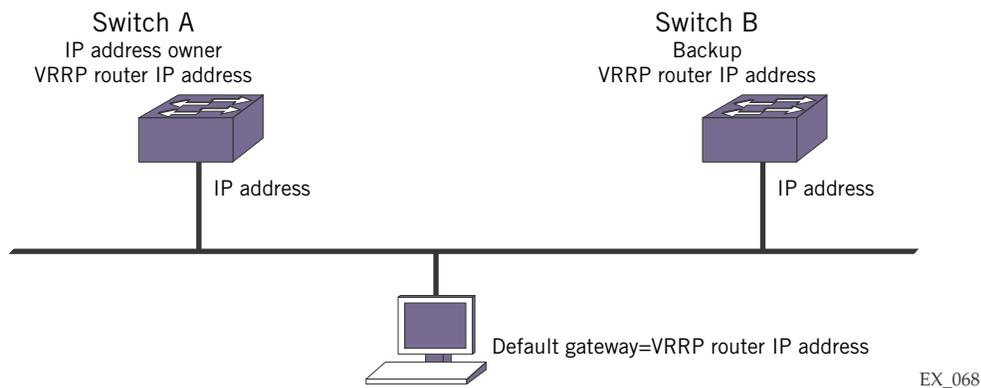
- [Overview on page 1097](#)
- [Configuring VRRP on page 1105](#)
- [Managing VRRP on page 1108](#)
- [Displaying VRRP Information on page 1109](#)
- [VRRP Configuration Examples on page 1109](#)

This chapter assumes that you are already familiar with the Virtual Router Redundancy Protocol (VRRP). If not, refer to the following publications for additional information:

- RFC 2338—*Virtual Router Redundancy Protocol (VRRP)*
- RFC 2787—*Definitions of Managed Objects for the Virtual Router Redundancy Protocol*
- RFC 3768—*Virtual Router Redundancy Protocol (VRRP) Version 2 for IPv4*
- RFC 5798—*Virtual Router Redundancy Protocol (VRRP) Version 3 for IPv4 and IPv6*
- Draft IETF VRRP Specification v2.06

Overview

VRRP, like the Extreme Standby Router Protocol (ESRP), allows multiple switches to provide redundant routing services to users. VRRP is used to eliminate the single point of failure associated with manually configuring a default gateway address on each host in a network. Without using VRRP, if the configured default gateway fails, you must reconfigure each host on the network to use a different router as the default gateway. VRRP provides a redundant path for the hosts. Using VRRP, if the default gateway fails, the backup router assumes forwarding responsibilities. An example VRRP topology is shown in [Figure 168](#).

Figure 168: Simple VRRP Network

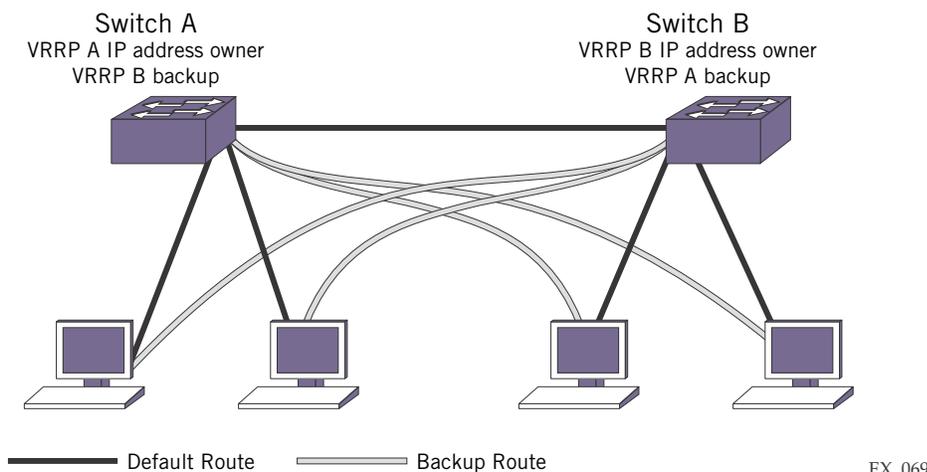
Switches A and B in [Figure 168](#) are both configured with the same VRRP router ID on the same VLAN, which establishes a VRRP relationship between the two routers. Because a single switch can support multiple VRRP relationships, each relationship is referred to as a VRRP router instance. Within a VRRP router instance, any VRRP router can become the *master*, but only one VRRP router can be master at a time. The master processes all client communications, and the other VRRP routers in the VRRP routing instance stand by, ready to take over if the master is no longer available.

Each switch in a VRRP topology has its own unique IP and MAC addresses, which are required for basic IP connectivity. For each VRRP router instance, there are shared VRRP IP and MAC addresses, which are used for network client communications. The *VRRP router IP address* is configured on all VRRP routers in a VRRP routing instance, and it is configured as the default gateway address on network clients. If the master VRRP router becomes unavailable, the backup VRRP router takes over using the same VRRP router IP address.

If the VRRP router IP address matches the actual IP address, that router is called the *IP address owner*. The IP address owner, which is Switch A in [Figure 168](#), has the highest priority value and will always become the master when VRRP is enabled and operating correctly. If the switch or the VRRP process on the switch stops, a backup switch (Switch B in [Figure 168](#)) takes over the master role and serves as the default gateway for network clients.

VRRP supports multiple backup routers. If the master VRRP router stops working, one of the backup routers takes over as described in [“VRRP Master Election” on page 1100](#).

VRRP also supports multiple VRRP router instances, which can be used to enable load sharing. [Figure 169](#) shows a VRRP load-sharing configuration.

Figure 169: VRRP Load-Sharing Configuration

EX_069

Switches A and B in [Figure 169](#) are each configured with two VRRP router instances. Switch A is the IP address owner and default master for VRRP instance 1, and Switch B is the IP address owner and default master for VRRP instance 2. Half the network clients are configured to use VRRP instance 1 as the primary gateway and VRRP instance 2 as the backup gateway. The other half of the network clients are configured to use VRRP instance 2 as the primary gateway and VRRP instance 1 as the backup gateway. When both switches are operating with VRRP, each switch supports half the clients in a load-sharing topology. If either switch fails or if VRRP is disabled on a switch, the remaining switch supports all network clients.

The following sections provide more information on VRRP:

- [VRRP Master Election on page 1100](#)
- [VRRP Master Preemption on page 1100](#)
- [VRRP Tracking on page 1101](#)
- [VRRP Address Support for IPv4 on page 1102](#)
- [VRRP Address Support for IPv6 on page 1102](#)
- [VRRPv3 Interoperation with VRRPv2 on page 1103](#)
- [VRRP Guidelines on page 1103](#)
- [VRRP and Hitless Failover on page 1104](#)

**NOTE**

Extreme Networks recommends that you do not enable VRRP on aggregated VLANs, which are also known as super VLANs.

VRRP Master Election

When a VRRP configured network starts, VRRP uses an election algorithm to dynamically assign *master* responsibility to one of the VRRP routers on the network. The VRRP master is determined by the following factors:

- VRRP priority—Possible values are 0 through 255. Value 255 is reserved for the VRRP router IP address owner, and value 0 is reserved for the master router, to indicate it is releasing master responsibility. Values 1 to 254 can be configured on backup routers to influence which backup router becomes the master when the master VRRP router is no longer available. The higher number has higher priority. The default value for backup routers is 100.
- Higher IP address—If multiple backup routers have the same configured priority, the router with the highest IP address becomes the master.

If the master router becomes unavailable, the election process begins and the backup router that wins the election assumes the role of master.

A new master is elected when one of the following things happen:

- VRRP is disabled on the master router.
- Loss of communication occurs between master and backup router(s).

If VRRP is disabled on the master interface, the master router sends an advertisement with the priority set to 0 to all backup routers. This signals the backup routers that they do not need to wait for the master down interval to expire, and the master election process can begin immediately.

The master down interval is set using the following formula: $3 * \text{advertisement interval} + \text{skew time}$. The advertisement interval is a user-configurable option, and the skew time is $(256 - \text{priority}) / 256$.



NOTE

An extremely busy CPU can create a short dual master situation. To avoid this, increase the advertisement interval.

VRRP Master Preemption

VRRP master preemption is a feature that allows a VRRP backup router with a higher VRRP priority to take control from a lower priority backup that is acting as the master. VRRP election occurs as described in “[VRRP Master Election](#)” on page 1100. VRRP preemption occurs when a VRRP backup router is added to the network or recovers, and that backup router has a higher priority than the current backup VRRP that is operating as the master.



NOTE

The VRRP router IP address owner always preempts, independent of the VRRP preemption setting.

When a VRRP backup router preempts the master, it does so in one of the following ways:

- If the preempt delay timer is configured for between 1 and 3600 seconds and the lower-priority master is still operating, the router preempts the master when the timer expires.
- If the preempt delay timer is configured for 0, the router preempts the master after 3 times the hello interval.
- If the higher priority router stops receiving advertisements from the current master for 3 times the hello interval, it takes over mastership immediately.

The preempt delay timer provides time for a recovering router to complete start up before preempting a lower-priority router. If the preempt delay timer is configured too low, traffic is lost between the time the preempting router takes control and the time when it has completed startup.

VRRP Tracking

Tracking information is used to track various forms of connectivity from the VRRP router to the outside world. The following sections describe VRRP tracking options and how to display information on them:

- [VRRP Tracking Mode](#)
- [VRRP VLAN Tracking](#)
- [VRRP Route Table Tracking](#)
- [VRRP Ping Tracking](#)
- [VRRP Configuration Examples](#)



NOTE

MPLS LSPs are not considered to be part of VRRP route tracking.

VRRP Tracking Mode

When a VRRP tracked entity fails, the VRRP router behavior is controlled by the tracking mode. The mode can be `all` or `any`. The default mode is `all`.

When the mode is `all`, the mastership is relinquished when one of the following events occur:

- All of the tracked VLANs fail
- All of the tracked routes fail
- All of the tracked PINGs fail

When the mode is `any`, the mastership is relinquished when any of the tracked VLANs, routes, or PINGs fail.

VRRP VLAN Tracking

You can configure VRRP to track connectivity of up to eight specified VLANs as criteria for failover. If no active ports remain on the specified VLANs, the router automatically relinquishes master status based on the tracking mode.

VRRP Route Table Tracking

You can configure VRRP to track specified routes in the route table as criteria for VRRP failover. If any of the configured routes are not available within the route table, the router automatically relinquishes master status based on the tracking mode.

VRRP Ping Tracking

You can configure VRRP to track connectivity using a simple ping to any outside responder. The responder may represent the default route of the router, or any device meaningful to network connectivity of the master VRRP router. If pinging the responder fails the specified number of times, consecutively, the router automatically relinquishes master status based on the tracking mode.

VRRP Address Support for IPv4

For IPv4 traffic, a primary IPv4 address is selected from the set of real interface addresses. VRRP advertisements are always sent using the primary IPv4 address as the source of the IPv4 packet.

The VRRP MAC address for an IPv4 VRRP router instance is an IEEE 802 MAC address in the following hexadecimal format (in Internet-standard bit-order):

```
00-00-5E-00-01-<vrid>.
```

The first three octets are derived from the IANA Organizational Unique Identifier (OUI). The next two octets (00-01) indicate the address block assigned to the VRRP router for the IPv4 protocol, and VRID is the VRRP instance identifier. This mapping provides for up to 255 IPv4 VRRP routers on a network.

When a VRRP router instance becomes active, the master router issues a gratuitous ARP response that contains the VRRP router MAC address for each VRRP router IP address. The master also always responds to ARP requests for VRRP router IP addresses with an ARP response containing the VRRP MAC address. Hosts on the network use the VRRP router MAC address when they send traffic to the default gateway.

VRRP Address Support for IPv6

IPv6 VRRP router advertisements are always sent using the VRRP virtual link-local address as the source address. Hosts on the LAN can use this link-local address as their default route gateway. If no VRRP link-local address is configured, a default value is derived as follows:
FE80::5E00:02{VRID}.

VRID is the VRRP instance identifier.



NOTE

The host portion of this address corresponds to the virtual MAC address associated with the VRRP router

When a backup VRRP router assumes the role of master, it must use the same link-local address in router advertisements as the previous master. Therefore, when configuring a backup VRRP router, you must either configure a virtual link local address that matches the link local address on the IP address owner or allow the virtual link local address to default to the derived value in the same manner as on the master.

Router advertisement prefixes are configured based on the VRRP IP addresses. The mask used for the prefix will be the smallest mask used by all VRRP IP addresses on a VLAN interface. The ExtremeXOS software supports multiple IPv6 addresses on an interface that can overlap. For example, you can add both 200d::1/48 and 200d::2/96 to a VLAN. IPv6 VRRP routers advertise the smallest mask that applies to all VRRP IP addresses. In this example, if VRRP IP address 200d::100 is added, the mask is 48.

The VRRP MAC address for an IPv6 VRRP router instance is an IEEE 802 MAC address in the following hexadecimal format (in Internet-standard bit-order):

```
00-00-5E-00-02-<vrid>.
```

The first three octets are derived from the IANA OUI. The next two octets (00-02) indicate the address block assigned to the VRRP router for IPv6 protocol, and VRID is the VRRP instance identifier. This mapping provides for up to 255 IPv6 VRRP routers on a network.

When a VRRP router assumes the role of master, it issues an unsolicited neighbor discovery (ND) neighbor advertisement message for each of the VRRP router IP addresses. The master also always responds to ND neighbor solicitations with ND neighbor advertisements using the VRRP MAC address.

VRRPv3 Interoperation with VRRPv2

RFC 5798 states that VRRPv2 and VRRPv3 interoperation is optional, and that mixing these two versions should only be done when transitioning from VRRPv2 to VRRPv3. VRRPv2 and VRRPv3 interoperation should not be implemented as a permanent solution.

This release supports configuration for the following modes of operation: VRRPv2, VRRPv3, and VRRPv2 and VRRPv3 interoperation.

VRRP Guidelines

The following guidelines apply to using VRRP:

- VRRP packets are encapsulated IP packets.
- The VRRP IPv4 multicast address is 224.0.0.18.
- The VRRP IPv6 multicast address is ff02::12.
- Duplicate VRIDs are allowed on the router but not on the same IP interface or VLAN.
- The maximum number of supported VRIDs per interface is seven.
- An interconnect link between VRRP routers should not be used, except when VRRP routers have hosts directly attached.
- A maximum of 128 VRID instances are supported on the router.
- Up to seven unique VRIDs can be configured on the router. VRIDs can be re-used, but not on the same interface.
- VRRP and the Spanning Tree Protocol (STP) can be simultaneously enabled on the same switch.
- When VRRP and BOOTP/DHCP relay are both enabled on the switch, the relayed BOOTP agent IP address is the actual switch IP address, not the virtual IP address.
- Extreme Networks does not recommend simultaneously enabling VRRP and ESRP on the same switch.
- Do not configure VRRP and ESRP on the same VLAN or port. This configuration is not allowed or supported.

- RFC 5798 describes a situation where a master VRRP router takes on a duplicate IP address due to interaction with the duplicate address detection (DAD) feature. To prevent such duplicate addresses, the DAD feature is disabled whenever a VRRP router is configured for IPv6 or IPv4.
- A VRRP router instance can be configured with multiple IP addresses on the same subnet or on different subnets, provided that all virtual IP addresses match the subnet address of a VLAN on the switch. For example, if a host switch has VLAN IP addresses in the 1.1.1.x and 2.2.2.x subnets, VRRP router instance 99 can contain virtual IP addresses in both those subnets as well.
- If a VRRP router instance is assigned priority 255, then the host router must own all the IP addresses assigned to the VRRP router instance. That is, each virtual IP address must match an IP address configured for a VLAN on the router.
- When a VRRPv2 instance spans routers using ExtremeXOS Version 12.6 and earlier and routers using ExtremeXOS Version 12.7 and later, routers using ExtremeXOS Version 12.6 and earlier log packet-size warning messages.

VRRP and Hitless Failover



NOTE

This section applies to Modular Switches and SummitStack only.

When you install two Management Switch Fabric Module (MSM) or Management Modules (MMs) in a BlackDiamond chassis, one MSM/MM (node) assumes the role of primary and the other node assumes the role of backup. The primary node executes the switch's management functions, and the backup acts in a standby role. Hitless failover transfers switch management control from the primary to the backup and maintains the state of VRRP. VRRP supports hitless failover. You do not explicitly configure hitless failover support; rather, if you have two nodes installed, hitless failover is available.

To support hitless failover, the primary node replicates VRRP protocol data units (PDUs) to the backup, which allows the nodes to run VRRP in parallel. Although both nodes receive VRRP PDUs, only the primary transmits VRRP PDUs to neighboring switches and participates in VRRP.

To initiate hitless failover on a network that uses VRRP:

- 1 Confirm that the primary and backup nodes are synchronized and have identical software and switch configurations using the `show switch {detail}` command. The output displays the status of the nodes, with the primary node showing `MASTER` and the backup node showing `BACKUP (InSync)`.
 - If the primary and backup nodes are not synchronized and both nodes are running a version of ExtremeXOS that supports synchronization, proceed to step 2.
 - If the primary and backup nodes are synchronized, proceed to step 3.
- 2 If the primary and backup nodes are not synchronized, use the `synchronize` command to replicate all saved images and configurations from the primary to the backup.

After you confirm the primary and backup nodes are synchronized, proceed to step 3.
- 3 If the primary and backup nodes are synchronized, use the `run failover` (formerly `run msm-failover`) command to initiate failover.

For more detailed information about verifying the status of the nodes and system redundancy, see “[Understanding System Redundancy—Modular Switches and SummitStack Only](#)” on page 81. For more information about hitless failover, see “[Understanding Hitless Failover Support—Modular Switches and SummitStack Only](#)” on page 85.

**NOTE**

For complete information about software licensing, including how to obtain and upgrade your license and what licenses are appropriate for these features, see [Appendix A, “Feature License Requirements.”](#)

Configuring VRRP

The following sections describe how to configure VRRP:

- [Configuration Overview on page 1105](#)
- [Creating and Deleting VRRP Router Instances on page 1106](#)
- [Adding and Deleting VRRP Router IP Addresses on page 1106](#)
- [Adding an IPv6 Link Local Address to a VRRP Router on page 1106](#)
- [Configuring the VRRP Router Advertisement Interval on page 1106](#)
- [Configuring VRRP Router Authentication on page 1107](#)
- [Configuring Master Preemption on page 1107](#)
- [Configuring VRRP Router Priority on page 1107](#)
- [Configuring the Accept Mode on page 1107](#)
- [Configuring VRRP Version Support on page 1107](#)
- [Configuring VRRP Tracking on page 1108](#)

Configuration Overview

The following procedure can be used to configure a simple VRRP topology:

- 1 Configure the VRRP IP address owner router as follows:
 - a Create a VLAN to serve as the VRRP router VLAN.
 - b Add an IP address to the VRRP VLAN.
 - c Create the VRRP router instance for the IP address owner (See [“Creating and Deleting VRRP Router Instances” on page 1106](#)).
 - d Add the IP address defined in Step 1b as a VRRP router IP address (See [“Adding and Deleting VRRP Router IP Addresses” on page 1106](#)).
 - e Enable VRRP on the switch (See [“Enabling and Disabling VRRP and VRRP Router Instances” on page 1109](#)).
- 2 Configure each backup VRRP router as follows:
 - a Create a VLAN to serve as the VRRP router VLAN. This name must match the name used for the appropriate VRRP IP address owner.
 - b Add an IP address to the VRRP VLAN. This address must be different from the IP address assigned to the VRRP IP address owner, but it must use the same subnet.
 - c Create the VRRP router instance that will serve as the backup instance (See [“Creating and Deleting VRRP Router Instances” on page 1106](#)).
 - d Configure the priority for the backup VRRP router to a value in the range of 1 to 254 (See [“Configuring VRRP Router Priority” on page 1107](#)).

- e Add the same VRRP router IP address that was added to the VRRP IP address owner instance (See “Adding and Deleting VRRP Router IP Addresses” on page 1106).
 - f Enable VRRP on the switch (See “Enabling and Disabling VRRP and VRRP Router Instances” on page 1109).
- 3 Configure network workstations to use the VRRP router IP address as the default gateway address.

Creating and Deleting VRRP Router Instances

To create a VRRP router instance, use the following command:

```
create vrrp vlan <vlan_name> vrid <vridval>
```

To delete a VRRP router instance, use the following command:

```
delete vrrp vlan <vlan_name> vrid <vridval>
```

Adding and Deleting VRRP Router IP Addresses

To add a VRRP router IP address to a switch, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> add <ipaddress>
```



NOTE

A VRRP routing instance can support IPv4 or IPv6 addresses, but it cannot support both types of addresses.

To delete a VRRP router IP address from a switch, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> delete <ipaddress>
```

Adding an IPv6 Link Local Address to a VRRP Router

To add an IPv6 link local address to a VRRP router, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> add virtual-link-local <vll_addr>
```

Configuring the VRRP Router Advertisement Interval

To configure the VRRP router advertisement interval, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> advertisement-interval <interval>
[seconds] | centiseconds]
```



NOTE

Extreme Networks recommends that you configure the same router advertisement interval in all VRRP routers. VRRPv3 supports a 40 second maximum advertisement interval.

Configuring VRRP Router Authentication

To configure VRRP router authentication, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> authentication [none | simplepassword <password>]
```



NOTE

VRRP router authentication is obsolete in VRRPv3. For backward compatibility, this feature is still supported in VRRPv2.

Configuring Master Preemption

To enable VRRP master preemption and configure the preempt delay timer, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> preempt {delay <seconds>}
```

To disable VRRP master preemption, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> dont-preempt
```

Configuring VRRP Router Priority

To configure the priority for a VRRP router, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> priority <priorityval>
```



NOTE

If VRRPv3 and VRRPv2 routers participate in VRRP instance, the VRRPv3 routers should be configured with a higher priority to ensure that they win master elections over VRRPv2 routers.

Configuring the Accept Mode

To configure the accept mode, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> accept-mode [on | off]
```

Configuring VRRP Version Support

To configure VRRP version support, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> version [v3-v2 | v3 | v2]
```

Configuring VRRP Tracking

The following sections describe how to configure VRRP tracking:

- [Configuring the Tracking Mode on page 1108](#)
- [Adding and Deleting Tracked Routes on page 1108](#)
- [Adding and Deleting Tracked VLANs on page 1108](#)
- [Adding and Deleting Tracked Pings on page 1108](#)

Configuring the Tracking Mode

To configure the tracking mode, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> track-mode [all | any]
```

Adding and Deleting Tracked Routes

To add a tracked route, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> add track-iproute <ipaddress>/  
<masklength>
```

To delete a tracked route, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> delete track-iproute <ipaddress>/  
<masklength>
```

Adding and Deleting Tracked VLANs

To add a tracked VLAN, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> add track-vlan <target_vlan_name>
```

To delete a tracked VLAN, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> delete track-vlan <target_vlan_name>
```

Adding and Deleting Tracked Pings

To add a tracked ping, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> add track-ping <ipaddress> frequency  
<seconds> miss <misses>
```

To delete a tracked ping, use the following command:

```
configure vrrp vlan <vlan_name> vrid <vridval> delete track-ping <ipaddress>
```

Managing VRRP

The following sections describe how to manage VRRP:

- [Enabling and Disabling VRRP and VRRP Router Instances on page 1109](#)
- [Clearing VRRP Counters on page 1109](#)

Enabling and Disabling VRRP and VRRP Router Instances

To enable VRRP or a VRRP router instance, use the following command:

```
enable vrrp {vlan <vlan_name> vrid <vridval>}
```

To disable VRRP or a VRRP router instance, use the following command:

```
disable vrrp {vlan <vlan_name> vrid <vridval>}
```

Clearing VRRP Counters

To clear the VRRP counters, use the following command:

```
clear counters vrrp {{vlan <vlan_name>} {vrid <vridval>}}
```

Displaying VRRP Information

The following sections describe how to view VRRP configuration and operation information:

- [Displaying VRRP Router Information on page 1109](#)
- [Displaying VRRP Router Information and Statistics for VLANs on page 1109](#)
- [Displaying VRRP Tracking Information on page 1109](#)

Displaying VRRP Router Information

To display VRRP router information for one or all VRs, use the following command:

```
show vrrp {virtual-router {<vr-name>}} {detail}
```

Displaying VRRP Router Information and Statistics for VLANs

To display VRRP information or statistics for a VLAN, use the following command:

```
show vrrp vlan <vlan_name> {stats}
```

Displaying VRRP Tracking Information

To view the status of tracked devices, use the following command:

```
show vrrp {virtual-router {<vr-name>}} {detail}
```

VRRP Configuration Examples

This section describes the following VRRP network configuration examples:

- [Simple VRRP Network Example on page 1110](#)
- [VRRP Load Sharing Example on page 1110](#)
- [VRRP Tracking on page 1111](#)

Simple VRRP Network Example

The topology for a simple VRRP network example is shown in [Figure 168 on page 1098](#). Switch A is the IP address owner, and Switch B is configured as the backup.

The configuration commands for switch A are as follows:

```
configure vlan vlan1 ipaddress 192.168.1.3/24
create vrrp vlan vlan1 vrid 1
configure vrrp vlan vlan1 vrid 1 priority 255
configure vrrp vlan vlan1 vrid 1 add 192.168.1.3
enable vrrp
```

The configuration commands for switch B are as follows:

```
configure vlan vlan1 ipaddress 192.168.1.5/24
create vrrp vlan vlan1 vrid 1
configure vrrp vlan vlan1 vrid 1 add 192.168.1.3
enable vrrp
```

VRRP Load Sharing Example

You can use two or more VRRP-enabled switches to provide a fully redundant VRRP configuration that supports load sharing on your network. The topology for a load sharing example is shown in [Figure 169 on page 1099](#). Switch A is the IP address owner for VRRP router instance 1 and the backup for VRRP instance 2. Switch B is the IP address owner for VRRP router instance 2 and the backup for VRRP instance 1.

The configuration commands for switch A are as follows:

```
configure vlan vlan1 ipaddress 192.168.1.3/24
create vrrp vlan vlan1 vrid 1
configure vrrp vlan vlan1 vrid 1 priority 255
configure vrrp vlan vlan1 vrid 1 add 192.168.1.3
create vrrp vlan vlan1 vrid 2
configure vrrp vlan vlan1 vrid 2 add 192.168.1.5
enable vrrp
```

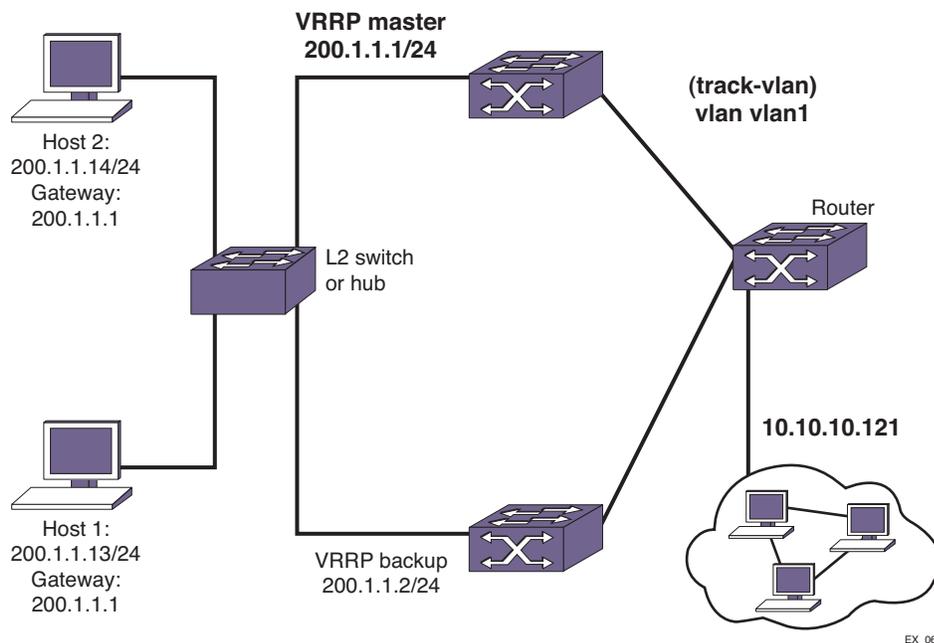
The configuration commands for switch B are as follows:

```
configure vlan vlan1 ipaddress 192.168.1.5/24
create vrrp vlan vlan1 vrid 2
configure vrrp vlan vlan1 vrid 2 priority 255
configure vrrp vlan vlan1 vrid 2 add 192.168.1.5
create vrrp vlan vlan1 vrid 1
configure vrrp vlan vlan1 vrid 1 add 192.168.1.3
enable vrrp
```

VRRP Tracking

Figure 170 is an example of VRRP tracking.

Figure 170: VRRP Tracking



To configure VLAN tracking, as shown in Figure 170, use the following command:

```
configure vrrp vlan vrrp1 vrid 2 add track-vlan vlan1
```

Using the tracking mechanism, if VLAN1 fails, the VRRP master realizes that there is no path to the upstream router through the master switch and implements a VRRP failover to the backup.

To configure route table tracking, as shown in Figure 170, use the following command:

```
configure vrrp vlan vrrp1 vrid 2 add track-iproute 10.10.10.0/24
```

The route specified in this command must exist in the IP routing table. When the route is no longer available, the switch implements a VRRP failover to the backup.

To configure ping tracking, as shown in Figure 170, use the following command:

```
configure vrrp vlan vrrp1 vrid 2 add track-ping 10.10.10.121 frequency 2 miss 2
```

The specified IP address is tracked. If the fail rate is exceeded, the switch implements a VRRP failover to the backup. A VRRP node with a priority of 255 may not recover from a ping-tracking failure if there is a Layer 2 switch between it and another VRRP node. In cases where a Layer 2 switch is used to connect VRRP nodes, Extreme Networks recommends that those nodes have priorities of less than 255.

30 MPLS

CHAPTER

This chapter includes the following sections:

- Overview on page 1113
- Configuring MPLS on page 1157
- Displaying MPLS Configuration Information on page 1168
- MPLS Configuration Example on page 1175
- Configuring MPLS Layer-2 VPNs (VPLS and VPWS) on page 1178
- VPLS VPN Configuration Examples on page 1182
- Configuring H-VPLS on page 1186
- Configuring Protected VPLS on page 1187
- Configuring RSVP-TE on page 1187
- RSVP-TE Configuration Example on page 1194
- Troubleshooting MPLS on page 1197

Overview

Multiprotocol Label Switching (MPLS) provides advanced IP services for switches that contain advanced ASICs that support MPLS. To configure MPLS on your switch, you need an enabled MPLS feature pack.



NOTE

MPLS and MPLS subfeatures are supported on the platforms listed for specific features in [Table 142](#) in [Appendix A, “Feature License Requirements.”](#)

This section describes MPLS and includes the following topics:

- How MPLS Works on page 1114
- MPLS Terms and Acronyms on page 1115
- LDP Support on page 1116
- MPLS Routing on page 1118
- Layer 2 VPN over MPLS Overview (VPLS and VPWS) on page 1124

- [H-VPLS Overview on page 1129](#)
- [Protected VPLS and H-VPLS with ESRP Redundancy Overview on page 1134](#)
- [VPLS STP Redundancy Overview on page 1138](#)
- [VPLS EAPS Redundancy Overview on page 1140](#)
- [RSVP-TE Overview on page 1143](#)
- [Supporting Quality of Service Features on page 1157](#)
- [Propagation of IP TTL on page 1157](#)

How MPLS Works

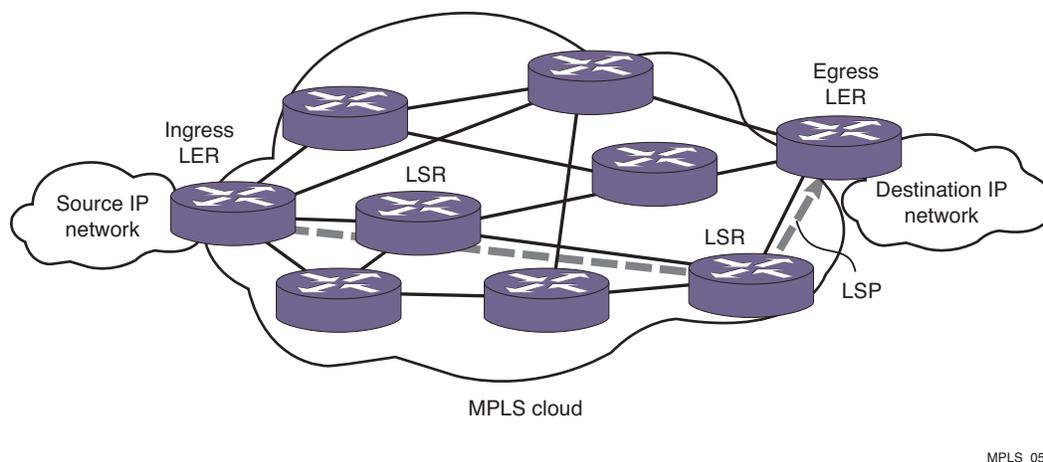
MPLS is a connection-oriented technology that allows routers to make protocol-independent forwarding decisions based on fixed-length labels. The use of MPLS labels enables routers to avoid the processing overhead of delving deeply into each packet and performing complex route lookup operations based upon destination IP addresses.

MPLS protocols are designed primarily for routed IP networks and work together to establish multiple, unidirectional Label Switched Path (LSP) connections through an MPLS network. Once established, an LSP can be used to carry IP traffic or to tunnel other types of traffic, such as bridged MAC frames. The tunnel aspects of LSPs, which are important in supporting virtual private networks (VPNs), result from the fact that forwarding is based solely on labels and not on any other information carried within the packet.

The MPLS protocols operate on *Label Switch Routers (LSRs)*. The router where an LSP originates is called the *ingress LSR*, while the router where an LSP terminates is called the *egress LSR*. Ingress and egress LSRs are also referred to as *Label Edge Routers (LERs)*. For any particular LSP, a router is either an ingress LER, an intermediate LSR, or an egress LER. However, a router may function as an LER for one LSP, while simultaneously functioning as an intermediate LSR for another LSP.

Figure 171 illustrates an MPLS network.

Figure 171: MPLS Network



In an MPLS environment, incoming packets are initially assigned *labels* by the ingress LER. The labels allow more efficient packet handling by MPLS-capable routers at each point along the forwarding path.

An MPLS label essentially consists of a short fixed-length value carried within each packet header that identifies a Forwarding Equivalence Class (FEC). The FEC tells the router how to handle the packet. An

FEC is defined to be a group of packets that are forwarded in the same manner. Examples of FECs include an IP prefix, a host address, or a VLAN ID.



NOTE

The label concept in MPLS is analogous to other connection identifiers, such as an ATM VPI/VCI or a Frame Relay DLCI.

By mapping to a specific FEC, the MPLS label efficiently provides the router with all of the local link information needed for immediate forwarding to the next hop. MPLS creates an LSP along which each LSR can make forwarding decisions based solely upon the content of the labels. At each hop, the LSR simply strips off the existing label and applies a new one that tells the next LSR how to forward the packet. This allows packets to be tunneled through an IP network.

MPLS Terms and Acronyms

Table 111 defines common MPLS terms and acronyms.

Table 111: MPLS Terms and Acronyms

Term or Acronym	Description
CSPF	Constrained Shortest Path First. Route selection determined by an algorithm based on available link bandwidth and path cost.
DoD	Downstream-on-Demand. Distribution of labels as a result of explicit upstream label requests.
DU	Downstream Unsolicited. Distribution of labels downstream without an explicit label request.
EXP bits	A three-bit <i>experimental</i> field in an MPLS shim header.
FEC	Forward Equivalence Class. A group of packets that are forwarded in the same manner (for example, over the same Label Switched Path).
Label	A short, fixed-length identifier used to forward packets from a given link.
Label stack	A set of one or more MPLS labels used by MPLS to forward packets to the appropriate destination.
Label swapping	Lookup and replacement of an incoming label with the appropriate outgoing label.
LDP	Label Distribution Protocol. A protocol defined by the IETF used to establish an MPLS Label Switched Path (LSP).
LER	Label Edge Router. A Label Switch Router that is at the beginning (ingress) or end (egress) of an LSP.
LSP	Label Switched Path. The unidirectional MPLS connection between two routers over which packets are sent. LSPs are established using LDP or RSVP-TE.
LSR	Label Switch Router. A router that receives and transmits packets on an MPLS network.
MPLS	MultiProtocol Label Switching. A set of protocols defined by the IETF used to transmit information based on a label-switching forwarding algorithm.
NHLFE	Next Hop Label Forwarding Entry. The NHLFE represents the MPLS router next hop along the LSP.
PHP	Penultimate Hop Popping. A label stack optimization used for conserving the number of allocated labels.
PW	Pseudo Wire. A logical point-to-point connection.
RSVP	Resource ReSerVation Protocol (RSVP). A resource setup protocol designed for an integrated services network.

Table 111: MPLS Terms and Acronyms (Continued)

Term or Acronym	Description
RSVP-TE	Resource ReSerVation Protocol-Traffic Engineering (RSVP-TE). The combination of RSVP and MPLS label signaling to provide traffic engineered LSPs as specified in <i>RFC 3209, RSVP-TE: Extensions to RSVP for LSP Tunnels</i> .
Shim header	MPLS-specific header information that is inserted between layer-2 and layer-3 information in the data packet.
SP	Service Provider. An entity that provides network services for individuals or organizations.
TE	Traffic Engineering. The provisioning of an autonomous flow along a specified network path.
Transport LSP	Any active LSP used to forward traffic through an MPLS network.
VPLS	Virtual Private LAN Service (VPLS). A multipoint Layer 2 VPN service that has the property that all PW tunnels within a VPN are signaled with the same vcid, where the vcid represents the VPN identifier.
VPN	Virtual Private Network (VPN). A logical private network domain that spans a public or service provider network infrastructure.
VPWS	Virtual Private Wire Service (VPWS). A point-to-point Layer 2 VPN service that operates over MPLS.

LDP Support

The Label Distribution Protocol (LDP) is a protocol defined by the IETF for the purpose of establishing MPLS LSPs. Using LDP, peer LSRs exchange label binding information to create LSPs. The LDP features supported in this release include:

- Downstream unsolicited label advertisement
- Liberal label retention
- Ordered control mode
- Advertisement of labels for direct interfaces, RIP routes, and static routes
- LDP loop detection
- Configurable LDP timers

This section describes the Extreme Networks implementation of LDP, and includes the following topics:

- [LDP Neighbor Discovery on page 1116](#)
- [Advertising Labels on page 1117](#)
- [Propagating Labels on page 1117](#)
- [Label Advertisement Modes on page 1117](#)
- [Label Retention Modes on page 1118](#)
- [LSP Control Modes on page 1118](#)

LDP Neighbor Discovery

LDP includes a neighbor discovery protocol that runs over UDP. Using the basic discovery mechanism, each LSR periodically multicasts a hello message to a well-known UDP port to which all LSRs listen. These hello messages are transmitted to the *all routers on this subnet* multicast group. When a neighbor is discovered, a hello-adjacency is formed and the LSR with the numerically greater IP address is denoted as the active LSR.

Hello messages must continue to be received periodically for the hello-adjacency to be maintained. The hold time that specifies the duration for which a hello message remains valid can be negotiated by the peer LSRs as part of the HELLO exchange. During the HELLO exchange, each LSR proposes a value and the lower of the two is used as the hold time.

Targeted LDP hello-adjacencies between potentially nondirectly connected LSRs are supported using an extended discovery mechanism. In this case, targeted hello messages are periodically sent to a specific IP address.

After the hello-adjacency is formed, the active LSR initiates establishment of a TCP connection to the peer LSR. At this point, an LDP session is initiated over the TCP connection. The LDP session consists of an exchange of LDP messages that are used to set up, maintain, and release the session.

Advertising Labels

You can control whether label mappings are advertised for:

- Direct routes
- RIP routes
- Static routes

In these cases the switch is acting as the egress LER for these LSPs.

Propagating Labels

LDP propagates label mappings for FECs that exactly match a routing table entry. In the case of label mappings received from an LDP peer, LDP checks for an exactly matching entry with a next hop IP address that is associated with the LDP peer from which a label mapping was received.

Label Advertisement Modes

LDP provides two modes for advertising labels:

- Downstream-on-demand (DoD)
- Downstream unsolicited (DU)

Using DoD mode, label bindings are only distributed in response to explicit requests. A typical LSP establishment flow begins when the ingress LER originates a label request message to request a label binding for a particular FEC (for a particular IP address prefix or IP host address). The label request message follows the normal routed path to the FEC. The egress LER responds with a label mapping message that includes a label binding for the FEC. The label mapping message then follows the routed path back to the ingress LSR, and a label binding is provided by each LSR along the path. LSP establishment is complete when the ingress LER receives the label mapping message.

Conversely, using DU mode, an LSR may distribute label bindings to LSRs that have not specifically requested them. These bindings are distributed using the label mapping message, as in downstream-on-demand mode. From an LDP message perspective, the primary difference using DU mode is the lack of a preceding label request message.

Architecturally, the difference is more significant, because the DU mode is often associated with a topology-driven strategy, where labels are routinely assigned to entries as they are inserted into the routing database. In either case, an LSR only uses a label binding to switch traffic if the binding was received from the current next hop for the associated FEC.

Both label advertisement modes can be concurrently deployed in the same network. However, for a given adjacency, the two LSRs must agree on the discipline. Negotiation procedures specify that DU mode be used when a conflict exists when using Ethernet links. Label request messages can still be used when MPLS is operating in unsolicited mode.

The Extreme LDP implementation supports DU mode only.

Label Retention Modes

LDP provides two modes for label retention:

- Conservative
- Liberal

Using conservative label retention mode, an LSR retains only the label-to-FEC mappings that it currently needs (mappings received from the current next hop for the FEC). Using liberal retention mode, LSRs keep all the mappings that have been advertised to them. The trade-off is memory resources saved by conservative mode versus the potential of quicker response to routing changes made possible by liberal retention (for example, when the label binding for a new next hop is already resident in memory).

The Extreme MPLS implementation supports liberal label retention, only.

LSP Control Modes

LDP provides two LSP control modes:

- Independent
- Ordered

Using independent LSP control, each LSR makes independent decisions to bind labels to FECs. By contrast, using ordered LSP control, the initial label for an LSP is always assigned by the egress LSR for the associated FEC (either in response to a label request message or by virtue of sending an unsolicited label mapping message).

More specifically, using ordered LSP control, an LSR only binds a label to a particular FEC if it is the egress LSR for the FEC, or if it has already received a label binding for the FEC from its next hop for the FEC. True to its name, the mode provides a more controlled environment that yields benefits such as preventing loops and ensuring use of consistent FECs throughout the network.

The Extreme MPLS implementation supports ordered LSP control, only.

MPLS Routing

This section describes how MPLS and IP routing work together to forward information on your network.

MPLS provides a great deal of flexibility for routing packets. Received IP unicast frames can be routed normally or tunneled through LSPs. If a matching FEC exists for a received packet, the packet may be transmitted using an LSP that is associated with the FEC. The packet is encapsulated using an MPLS shim header before being transmitted.

Received MPLS packets can be label switched or routed normally toward the destination. Packets that are in the middle of an LSP are label switched. The incoming label is swapped for a new outgoing label

and the packet is transmitted to the next LSR. For packets that have arrived at the end of an LSP (the egress end of the LSP), the label is popped. If this label is the bottom of the stack, the shim header is stripped and the packets are routed to the destination as normal IP packets.

**NOTE**

Multicast routing is not supported.

An MPLS domain is generally defined to be an OSPF or IS-IS autonomous system (AS). You can use MPLS to reach destinations inside one of these AS types. You can also use MPLS to tunnel through all or part of an AS in order to reach destinations outside of the AS.

This section describes the following topics:

- [MPLS Layer Details on page 1119](#)
- [Routing Using Matching and Calculated LSP Next Hops on page 1121](#)
- [Matching LSP Next Hops on page 1122](#)
- [OSPF Calculated LSP Next Hops on page 1122](#)
- [BGP Calculated LSP Next Hops on page 1123](#)
- [LSP Precedence and Interaction on page 1123](#)
- [Multivendor Support for Calculated LSPs on page 1123](#)

MPLS Layer Details

This section describes the MPLS layer and includes the following topics:

- [MPLS Shim Header on page 1119](#)
- [MPLS Label Stack on page 1120](#)
- [Penultimate Hop Popping on page 1120](#)
- [Label Binding on page 1121](#)
- [Label Space Partitioning on page 1121](#)

MPLS can be thought of as a *shim-layer* between Layer 2 and Layer 3 of the protocol stack. MPLS provides connection services to layer-3 functions while making use of link-layer services from layer-2. To achieve this, MPLS defines a *shim header* that is inserted between the link layer header and the network layer header of transmitted frames. The format of a 32-bit MPLS shim header is illustrated in [Figure 172](#).

Figure 172: MPLS Shim Header

Label (20 bits)	EXP (3 bits)	bottom-of-stack (1 bit)	TTL (8 bits)
--------------------	-----------------	----------------------------	-----------------

MPLS_01

MPLS Shim Header. The MPLS shim header contains the following fields:

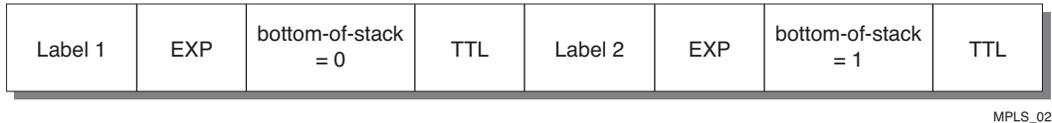
- 20-bit label
- 3-bit experimental (EXP) field

The EXP field can be used to identify different traffic classes to support the DiffServ QoS model.

- 1-bit bottom-of-stack flag
The bottom-of-stack bit is set to 1 to indicate the last stack entry.
- 8-bit Time-To-Live (TTL) field.
The TTL field is used for loop mitigation, similar to the TTL field carried in IP headers.

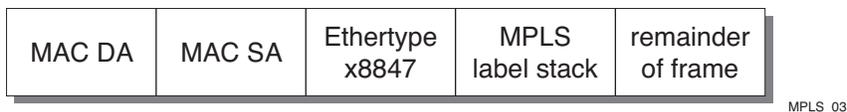
MPLS Label Stack. The format of an MPLS label stack containing two MPLS shim header entries is shown in [Figure 173](#).

Figure 173: MPLS Label Stack



[Figure 174](#) illustrates the format of a unicast MPLS frame on an Ethernet link. The MAC addresses are those of the adjacent MPLS router interfaces. The x8847 Ethertype value indicates that the frame contains an MPLS unicast packet. A different Ethertype value (x8848) is used to identify MPLS multicast packets.

Figure 174: MPLS Unicast Frame on Ethernet



[Figure 175](#) shows the format of a unicast MPLS frame that contains an 802.1Q VLAN tag. In both cases, the Ethertype values no longer identify the network layer protocol type. This implies that, generally, the protocol type must be inferable from the MPLS label value(s). For example, when only one type of protocol is carried on a given LSP.

Figure 175: MPLS Unicast Frame on Tagged Ethernet VLAN



NOTE

For more detailed information on MPLS encapsulations, see RFC 3032, MPLS Label Stack Encoding.

Penultimate Hop Popping. Penultimate hop popping (PHP) is an LSR label stack processing optimization feature. When enabled, the LSR can *pop* (or discard) the remaining label stack and forward the packet to the last router along the LSP as a normal Ethernet packet.

By popping the label stack one hop prior to the LSP egress router, the egress router is spared having to do two lookups. After the label stack has been popped by the penultimate hop LSR, the LSP egress router must only perform an address lookup to forward the packet to the destination.

PHP label advertisements using implicit NULL labels can be optionally enabled. Support for receiving implicit NULL label advertisements by neighbor LSRs is always enabled. For example, if an LSR advertises implicit NULL labels for IP prefixes, the neighbor LSRs must support PHP.

Label Binding. Label binding is the process of, and the rules used to, associate labels with FECs. LSRs construct label mappings and forwarding tables that comprise two types of labels: labels that are locally assigned and labels that are remotely assigned.

Locally assigned labels are labels that are chosen and assigned locally by the LSR. For example, when the LSR assigns a label for an advertised direct interface. This binding information is communicated to neighboring LSRs. Neighbor LSRs view this binding information as remotely assigned.

Remotely assigned labels are labels that are assigned based on binding information received from another LSR.

Label Space Partitioning. The Extreme implementation partitions its label space as described in Table 112.

Table 112: MPLS Label Space Partitions

Summit X460, X480, and X670 Series Switches, BlackDiamond X8 and 8900 Series Switches ^a , and E4G-200, E4G-400 Cell Site Routers	Label Partition Description
x00000-x0000f x00010-x00073 0x74-0x1fff: for BlackDiamond 8900 xl-series and X8 series, and Summit X480, x460 0x74-0xffff: for Summit X670 and BlackDiamond 8900 xm-series 0x74-0xda9: for E4G-200 0x74-0x1da9: for E4G-400 0x74-0x1fff: for BlackDiamond 8900 xl-series and X8 series, and Summit X480, x460 0x74-0xffff: for Summit X670 and BlackDiamond 8900 xm-series 0x74-0xda9: for E4G-200 0x74-0x1da9: for E4G-400	Defined/reserved by MPLS standards specified in RFC 3032. Static Partition—Used for statically assigned labels. Dynamic LSR Partition—Used at an intermediate LSR where a label switch occurs. Dynamic Egress Label Partition—Used at an LER where a label pop occurs.
a = For the BlackDiamond 8900 series switches, MPLS is only supported on the xl- and xm-series modules.	

The data path uses the label partition bits in conjunction with the bottom-of-stack flag to efficiently determine how a label should be processed.

No hard limits are imposed on the maximum size of the label stack, other than the constraint of not exceeding the maximum frame size supported by the physical links comprising the LSP. You should enable jumbo frame support on all ports. The jumbo frame size should be set to accommodate the addition of a maximally-sized label stack. For example, a jumbo frame size of at least 1530 bytes is needed to support a two-level label stack on a tagged Ethernet port and a jumbo frame size of at least 1548 bytes is needed to support a VPLS encapsulated MPLS frame.

Routing Using Matching and Calculated LSP Next Hops

Normally, a route table prefix is associated with a gateway or next hop IP address. Using MPLS, a route table prefix can also be associated with an LSP that can be used as the *next hop*. There are two types of LSP next hops that can be used to route a packet to its destination:

- Matching LSP next hop

An LSP is considered matching with respect to an FEC if it has been associated with that FEC via LDP or RSVP-TE. An example of this is an IPv4 prefix for which a matching label mapping has been received by LDP. Matching LSPs are supported for all route origin types.

- **Calculated LSP next hop**

An LSP is considered calculated with respect to an FEC if it has been associated with that FEC via a routing protocol. Both OSPF and BGP can perform the calculations necessary to associate a route table prefix with an LSP next hop.

Figure 176 illustrates the concept of matching and calculated LSPs.

Figure 176: Matching and Calculated LSP Next Hops

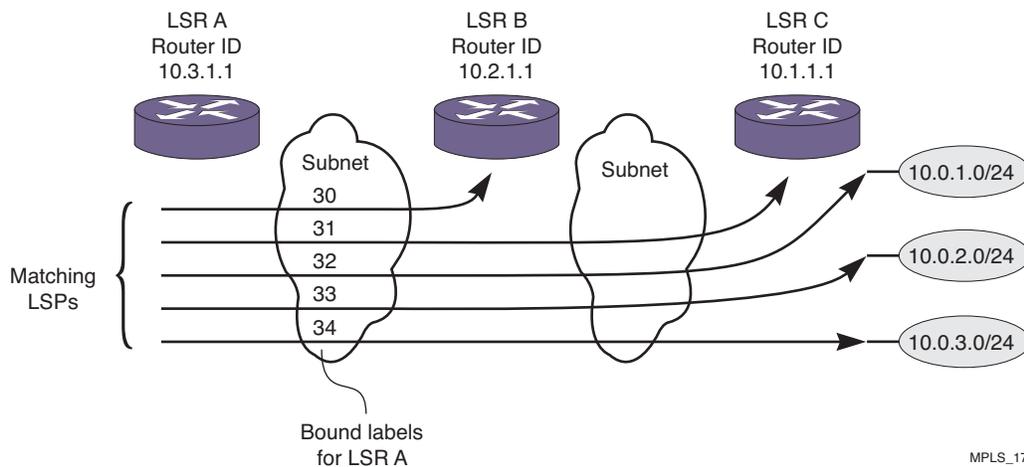


Table 113 describes the label bindings in the MPLS forwarding table for LSR A that are maintained for FECs reachable via LSR A to LSR C, shown in Figure 176.

Table 113: Label Bindings for LSR A

Destination	Next Hop	Matching LSP Next Hop Label	Calculated LSP Next Hop Label
10.1.1.1/32	10.2.1.1	31	30
10.0.1.0/24	10.2.1.1	32	31
10.0.2.0/24	10.2.1.1	33	31
10.0.3.0/24	10.2.1.1	34	31

Matching LSP Next Hops

A matching LSP next hop is always preferred over a calculated LSP next hop. Matching LSP next hop entries are added to the route table when an LSP becomes operational. They are deleted when an LSP is no longer operational.

OSPF Calculated LSP Next Hops

Managing calculated LSP next hop entries is more involved. The OSPF Shortest Path First (SPF) algorithm checks the availability of LSPs to remote OSPF routers during a calculation. The intra-area SPF algorithm begins with the calculating router as the root of a graph. The graph is expanded by examining the networks connected to the root and then examining the routers connected to those

networks. Continuing in this manner, the graph is built as a series of parent and child nodes. A check is made for a matching LSP next hop as each entry is added. A check is also made for an LSP next hop that can be inherited from the parent node. These inherited LSP next hops are referred to as *calculated* LSP next hops. Thus, for each route table entry, the modified SPF algorithm determines whether a matching LSP next hop is available and whether a calculated LSP next hop is available for use whenever a matching LSP next hop is not present.

The modification to the SPF algorithm described above is important, because it enables the capabilities provided by LDP or RSVP-TE LSPs to be fully utilized, while minimizing the resources devoted to label management.

For example, in a network where all the LERs/LSRs implement this feature (such as an all-Extreme MPLS network), labels only need to be advertised for the router IDs of the LERs/LSRs. Yet, LSPs can still be used to route traffic destined for any OSPF route.

More specifically, LSPs can be used for all routes advertised by OSPF, with the possible exception of LDP LSPs to routes summarized by OSPF area border routers (ABRs). The problem with using routes summarized by OSPF ABRs is that route summarization can prevent label mappings from being propagated for the links internal to the area being summarized, since an LSR only propagates LDP labels for FECs that exactly match a routing table entry.

BGP Calculated LSP Next Hops

BGP can also calculate how to use LSPs to reach BGP next hops. For example, an IBGP session is established across the OSPF/MPLS backbone, and the communicating routers run both OSPF and IBGP. When an IBGP route is installed, BGP determines whether a matching LSP next hop exists to the destination. If not, it checks for an LSP to the BGP next hop. If an LSP exists to the BGP next hop, that LSP is used as an LSP next hop for the IBGP route.

The recalculation requirements for BGP are similar to those for OSPF; when an LSP to a BGP next hop router changes state, the BGP routing table entries must be checked to ensure their LSP next hop information is still valid.

LSP Precedence and Interaction

A longest prefix match (LPM) is determined for all packets. If an LSP next hop is available, routed IP traffic may be forwarded over an LSP using the LSP next hop. With respect to a given prefix, LSP next hops can be either matching or calculated, and can be based on LDP or RSVP-TE LSPs. Matching LSP next hops are preferred over calculated LSP next hops and RSVP-TE based LSPs are preferred over LDP LSPs. Also, RSVP-TE LSPs can be configured to enable or disable their use as LSP next hops.

Therefore, if a more preferred LSP is established, routed IP traffic may begin to use a new LSP next hop. Likewise, if a preferred LSP is torn down, routed traffic may begin to use the next best LSP next hop. These changes can take place when there is an OSPF routing topology change, an LDP label advertisement event, or a RSVP-TE signaling action.

Multivendor Support for Calculated LSPs

Unfortunately, some MPLS implementations do not support the ability to forward packets received on an egress LSP to their OSPF router ID and/or BGP next hop address. If your MPLS network includes equipment that does not support this type of IP forwarding, you can use configuration commands to explicitly control the use of calculated LSP next hops.

The following commands enable and disable all use of LSP next hops. No IP traffic is routed over an LSP when `mpls-next-hop` IP routing capability is disabled.

```
enable iproute mpls-next-hop
disable iproute mpls-next-hop
```

**NOTE**

You can enable the use of LSP next hops, or you can enable DHCP/BOOTP relay. The software does not support both features at the same time.

These commands enable and disable the calculation of LSP next hops by OSPF:

```
enable ospf mpls-next-hop
disable ospf mpls-next-hop
```

This command enables and disables the calculation of LSP next hops by BGP:

```
enable bgp mpls-next-hop
disable bgp mpls-next-hop
```

Layer 2 VPN over MPLS Overview (VPLS and VPWS)

Layer 2 virtual private networking (VPN) services over MPLS include Virtual Private LAN Services (VPLS) and Virtual Private Wire Services (VPWS). These services enable Layer-2 VPN service offerings in a simple manner that is easy to deploy and operate. Layer-2 VPN services, based on a combination of Ethernet and MPLS/IP technologies, are designed to enable service providers to offer Ethernet business private line services. These services use a simple Layer-2 interface at the customer edge and benefit from the resilience and scalability of an MPLS/IP core.

VPLS provides a virtual LAN between multiple locations. VPWS provides a virtual dedicated line between only two locations.

This section describes Layer-2 VPNs and includes the following topics:

- [Layer 2 VPN Support on page 1124](#)
- [Layer 2 VPN Service Delimiters on page 1125](#)
- [MPLS Pseudo Wires on page 1125](#)
- [Layer 2 VPN Domains on page 1127](#)
- [MAC Learning on page 1128](#)
- [Spanning Tree Protocols on page 1128](#)
- [IP Protocol Considerations on page 1128](#)
- [MPLS Layer 2 VPN Characteristics on page 1129](#)

Layer 2 VPN Support

The LDP Layer 2 VPN implementation includes support for:

- LDP signaling support for pseudo wire ID (PWid) FEC for pseudo wire (PW) establishment.
- Use of LDP or RSVP-TE to establish transport LSPs.
- Tunnel endpoints are identified via configured IP addresses.
- Different VLAN IDs at each end of a PW, with the VLAN ID set by the egress switch to match that of the locally configured VLAN.

- Operations as VPLS, H-VPLS, or VPWS node.
- VLAN, VMAN, and port edge services (no port-qualified VLAN service).
- Flooding of Layer 2 packets to multiple PWs when operating as a VPLS or H-VPLS node.

**NOTE**

The implementation does not include support for pseudo wire participation in running the Spanning Tree Protocol.

Layer 2 VPN Service Delimiters

Service delimiters are used to define how the customer is identified to the Layer 2 VPN service. There are multiple types of service delimiters. The ExtremeXOS software currently supports three types. The first is a VLAN service. This service transparently interconnects two or more VLAN segments together over an MPLS network. The configured VLAN IDs for the customer switch interfaces are not required to match, as long as the egress LSR overwrites the VLAN tag with the locally defined VLAN ID. The second service is a VMAN service, which interconnects two or more VMAN segments. The service operates like the VLAN service but uses the VMAN tag instead of the VLAN tag to identify the service. As with the VLAN service, the interconnected VMAN segments do not need to have matching VMAN IDs. The third service is a port service, which transparently interconnects two or more ports together over an MPLS network. Traffic is transported unmodified between ports.

The VLAN and VMAN services are configured by adding the service VLAN or a VMAN to a VPLS or VPWS. The port service is not explicitly configured but is emulated using a combination of Layer 2 VPN capabilities. First a VMAN must be configured and the port added untagged to the VMAN. The service VMAN is then added to the VPLS or VPWS. At this point all traffic received on the port is VMAN encapsulated for transmission across the Layer 2 VPN. To transmit the traffic across the Layer 2 VPN as it was received on the port, the VPLS or VPWS is configured to exclude the service tag. By excluding the service tag, the VMAN tag is stripped prior to being transmitted from the switch. This configuration provides port mode service and allows one or multiple ports to be associated with a Layer 2 VPN.

MPLS Pseudo Wires

MPLS pseudo wire (PW) tunnels are logical connections between two LERs over an LSP. Pseudo wires are signaled based on the configured PW identifier (pwid). The signaled PW label is used to create a two-label-stack shim header on PW encapsulated packets. The outer label is the transport LSP label obtained from LDP or RSVP-TE and the inner label is the signaled PW label. LERs also signal the PW type when attempting to establish a PW. The ExtremeXOS software supports only the PWid type FEC. The Generalized ID FEC type is currently not supported.

Transporting 802.1Q Tagged Frames. When an 802.1Q Ethernet frame is encapsulated for transport over a VC tunnel, the entire frame is included, except for the preamble and FCS.

There is a configuration option that determines whether the 4-byte VLAN tag field is included in the transmitted packet. By default, the tag field is not included. If the tag field is not included, the egress LER may add one. If it is included, the tag service identifier may be overwritten by the egress LER. The ability to add a tag field or to overwrite the service identifier at the egress node allows two (possibly independently administered) VLAN segments with different VLAN IDs to be treated as a single VLAN.

The following command can be used to include the VLAN tag field:

```
configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] {dot1q [ethertype <hex_number> | tag [include | exclude]]} {mtu <number>}
```

This command can also be used to control the overwriting of the 802.1Q ethertype when the VLAN tag field is included. In this case, the ingress node prior to transmitting the encapsulated packet overwrites the ethertype. This allows devices with a configurable VLAN tag ethertype to interoperate.

Establishing LDP LSPs to PW Endpoints. Establishing a PW requires both an LSP and an LDP session between the two endpoints. The local PW endpoint is the MPLS LSR ID. The remote PW endpoint is identified using an IP address configuration parameter.

When using LDP to establish the LSPs, each endpoint needs to advertise a label mapping for an LSP to its local endpoint address. To ensure that its LDP peers use the label mapping, a corresponding IGP route should also be advertised for the address. For example, when using OSPF, an OSPF route with prefix length 32 should be advertised for the configured IP address.

It is highly recommended that you configure a loopback VLAN using the IP address of the local endpoint (the MPLS LSR ID). Use prefix length 32 for the IP address configured for the loopback VLAN. When you configure a loopback VLAN, the IP address used to identify the endpoint remains active, even when one or more of the LSR VLAN interfaces go down. Should a remote peer normally use one of the *down* interfaces, the normal IGP and LDP recovery procedures allow the PW to use one of the remaining *up* interfaces to minimize the network outage.

You should also configure the loopback VLAN for MPLS using the `configure mpls add vlan <vlan_name>` command. The addition of the loopback VLAN to MPLS causes LDP to include the IP address in LDP address messages. Some implementations (including the ExtremeXOS software) require this information to determine the correct LDP session over which to advertise label mappings for VC FECs (see “Using LDP to Signal PW Label Mappings” on page 1126).



NOTE

Neither MPLS nor LDP have to be enabled on the loopback VLAN.

There are two options to initiate the LDP advertisement of an LSP to the local MPLS LSR ID when a loopback VLAN has been configured for that IP address:

- Configure MPLS LDP to advertise a direct interface whose IP address matches the LSR ID and has prefix length 32. Use the `configure mpls ldp advertise direct lsr-id` command to do this.
- Configure MPLS LDP to advertise direct interfaces using the `configure mpls ldp advertise direct all` command.



NOTE

This causes LDP to advertise label mappings for all VLANs that have an IP address configured and have IP forwarding enabled.

While both of the above methods initiate the advertisement of a label mapping for an LSP to the local endpoint, the first method is the preferred method.

Using LDP to Signal PW Label Mappings. Just as LDP advertises label mappings for LSPs, it can also be used to advertise label mappings for Layer 2 VPNs. In this case, the signaled FEC information

describes a particular Layer 2 VPN. This FEC is often called a Virtual Circuit FEC or VC FEC. The VC FEC information includes a PW ID that is a 32-bit numeric field. Unlike LSP label advertisements that are usually sent to all possible upstream peers, the VC FEC information is sent only to the configured remote endpoint.

When the first Layer 2 VPN is configured to a remote peer, MPLS automatically creates a targeted hello adjacency entity for establishing an LDP session. Once the session is established, LDP passes the VC FEC label mapping associated with the Layer 2 VPN. Once VC FECs for the same PW ID have been exchanged in each direction, MPLS is ready to associate the PW with an LSP to the remote endpoint as described in “[LSP Selection](#)” on page 1127.

To determine the correct LDP session over which to send a VC FEC, MPLS checks the IP addresses learned from its LDP peers via LDP address messages. The ExtremeXOS software MPLS expects to find the IP address of a remote PW peer among the addresses received over the LDP session to that peer.

To insure that the local endpoint IP address is included in LDP address messages, it is highly recommended to configure MPLS on a loopback VLAN as described in “[Establishing LDP LSPs to PW Endpoints](#)” on page 1126. Use the command `configure mpls add vlan <vlan_name>` to configure MPLS on the loopback VLAN. It is not required that LDP or MPLS be enabled on the VLAN for the associated IP address to be advertised in LDP address messages.

LSP Selection. A PW can be configured to use any available LSP to the peer endpoint IP address, or the PW can be configured to use one or more specific *named* LSPs. In either case, the LSP has to egress (terminate) at the remote endpoint. In the case of an LDP LSP, the LSP's FEC has to be a /32 prefix length to the endpoint IP address. In the case of a RSVP-TE LSP, the destination address has to be that of the remote endpoint. When configured to use any available LSP, MPLS gives preference to RSVP-TE LSPs if any exist to the remote endpoint. As a single LSP is chosen to carry the PW traffic, if multiple LSPs of the chosen type exist, the decision of which LSP of this type to use is non-deterministic.

The command `configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] peer <ipaddress> [add | delete] mpls lsp <lsp_name>` forces the PW to use the specified named LSP. If multiple named LSPs are configured, only one is used to carry the PW. The decision of which of the multiple configured LSPs to use is non-deterministic.

RSVP-TE can be configured to allow specific types of traffic on an LSP. By default, LSPs are used to transport all traffic. Optionally, named LSPs can be configured to allow only IP traffic or only VPN traffic. This can be used to control the LSP selection for specific types of packets. For example, if both LDP and RSVP-TE LSPs exist and the RSVP-TE LSPs are configured to transport only VPN traffic, all IP traffic is forwarded using LDP LSPs. Since RSVP-TE LSPs are preferred over LDP LSPs, VPN traffic flows over the RSVP-TE LSPs. The command `configure mpls rsvp-te lsp <lsp_name> transport ip-traffic deny` configures this behavior for the specified RSVP-TE LSP.

Layer 2 VPN Domains

Layer 2 VPN domains are created by adding PWs to each peer LSR to build a fully-meshed interconnected VPLS. For each peer added, a PW is signaled that is used to carry traffic from the local LSR to the remote peer LSR. Flood traffic from the local service (broadcast, multicast, and unknown unicast packets) is replicated and forwarded across all PWs in the VPLS. Each peer receives one copy of the packet for delivery to its locally attached service. As MAC learning occurs on PWs, unicast packets to a known destination MAC address are forwarded to the peer over the PW from which the MAC address was learned.

MAC Learning

Learned MAC addresses are associated with the PWs from which the packets are received. The learned MAC address is always inserted into the forwarding database (FDB) as though it was learned on the local service VLAN (and not the VLAN identified in the dot1q tag in the received PW packet). MAC addresses learned from PWs use a different FDB aging timer than those MAC addresses learned on Ethernet interfaces. Different FDB aging timers are maintained for Ethernet and pseudo wire Layer 2 VPN FDB entries. By default both aging timers are set to 300 seconds. However, the aging timers for each type of FDB entry can be configured to different values. Note that PW FDB entries are not refreshed; they age out based on the configured aging timer setting, unless you have disabled the aging timer. Ethernet FDB entries automatically refresh with use, and do not age out unless they are not used for the length of time configured for the aging timer. Any MAC address associated with a PW is automatically cleared from the FDB when the PW label is withdrawn.

Spanning Tree Protocols

There is some debate as to the benefit of supporting Spanning Tree Protocols (STP) within a Layer-2 VPN. The idea is that STP protocols can be used to provide redundant VPN data paths that can be unblocked if the STP detects a spanning tree topology failure. In general, it is believed that introducing STP to VPLS increases network complexity with very little real benefit.

MPLS already provides a significant level of redundancy for the LSP over which a PW is carried. For example, if a PW is using an LDP established LSP, provided there are parallel routed paths to the PW endpoint, the PW automatically shifts from a withdrawn or failed LSP to the next best available LSP. For transport LSPs established using RSVP-TE, secondary LSPs can be configured that can be hot-swapped in the event of a primary LSP failure. Fast-reroute detour LSPs can also be used to protect RSVP-TE LSPs. Thus, even though the underlying transport LSP might have changed, the Layer 2 VPN data plane remains unaffected.

For these reasons, VPLS and STP are not normally enabled on the same VLAN. The exception is for local customer network redundancy such as shown in [“VPLS STP Redundancy Overview” on page 1138](#).

When STP is not enabled on a VPLS VLAN, the BPDU functional address is not inserted into the FDB for this VLAN and all received BPDU packets are flooded across the Layer 2 VPN. In this scenario, a single large spanning tree topology spanning all interconnected Layer 2 VPN service sites is constructed. Note that this is not a recommended configuration for a Layer 2 VPN service. Depending on the packet latency within the backbone network, STP timers might need to be tuned to build and maintain reliable topologies.

Currently, most ExtremeXOS software Layer 2 protocols cannot be configured on MPLS Layer 2 VPN domains. Likewise, the following protocols cannot be enabled on a Layer 2 VPN service VLAN:

- VRRP
- ESRP
- EAPS control VLAN

IP Protocol Considerations

The ExtremeXOS software allows an IP address to be configured for a Layer 2 VPN service VLAN. This is permitted to allow the switch to use the IP ping and traceroute functions to and from other nodes on the VLAN. It is envisioned that any such IP address is configured temporarily to assist in network verification.

As such, the ExtremeXOS software does not allow IP forwarding to be enabled on a Layer 2 VPN service VLAN for either IPv4 or IPv6. Therefore, any higher-level protocol that requires IP forwarding to be enabled cannot be enabled on a Layer 2 VPN service VLAN. For example, OSPF cannot be enabled on a VPLS service VLAN. In addition, IGMP snooping cannot be enabled on a VPLS service VLAN.

MPLS Layer 2 VPN Characteristics

Characteristics of a Layer 2 VPN include:

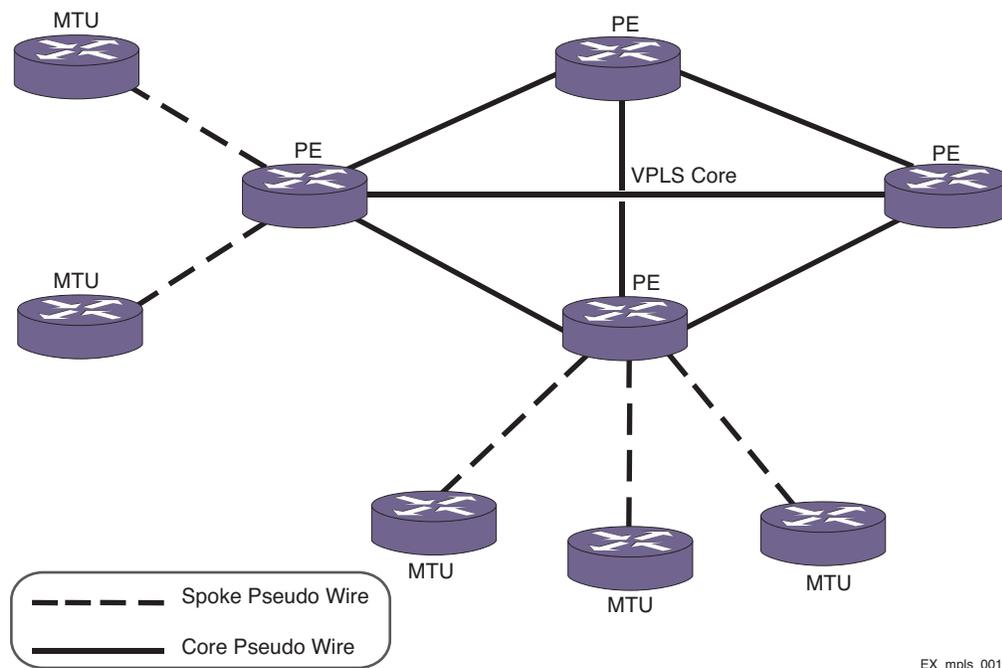
- Use of LDP or RSVP-TE to establish the underlying pseudo wire transport LSPs.
- Pseudo wire endpoints are identified through configured VPLS/VPWS peer IP addresses.
- Configuration of a Layer 2 VPN pseudo wire ID doubles as VPN ID.
- Customer packet VLAN tags may be overwritten on egress from the pseudo wire allowing local service VLANs or VMANs interconnected over the same Layer 2 VPN to have different IDs.
- Customer packet VLAN tags can be included or excluded from packets transmitted on the pseudo wire.
- Customer packet VLAN tag ethertype value can be modified before packet is transmitted on the pseudo wire, allowing local service VLANs or VMANs interconnected over the same VPLS to have different 802.1Q tag ethertype values.
- Support for full-mesh VPN architectures.
- Support for VLAN, VMAN, and port Layer 2 VPN services.
- Support for enabling and disabling VPLS and/or the VPLS service.
- Support for enabling and disabling VPWS and/or the VPWS service.

H-VPLS Overview

VPLS requires a full mesh of pseudo wires between all Provider Edge (PE) peers. As MPLS is pushed to the edge of the network, this requirement presents a number of problems. One problem is the increased number of pseudo wires required to service a large set of VPLS peers. In a full-mesh VPLS, pseudo wires must be established between all VPLS peers across the core. Full-mesh networks do not scale well due to the number pseudo wires that are required, which is $p(p-1)$, where p is the number of peer devices in the network. Hierarchical VPLS (H-VPLS) networks can dramatically increase network scalability by eliminating the p^2 scaling problem.

In a hierarchical VPLS network, a spoke node (often a Multi-Tenant Unit - MTU) is only required to establish a pseudo wire to a single core PE. Thus the number of pseudo wires required in the provider's network is $c(c-1) + s$, where c is the number of core PE nodes and s is the number of spoke MTU edge devices. This is a significant reduction in the number of pseudo wires that need to be established and maintained. For example, a 10 core PE network with 50 MTU devices per core PE requires almost 260,000 pseudo wires using a full-mesh VPLS design. A hierarchical VPLS design requires only 590 pseudo wires.

An example H-VPLS network is shown in [Figure 177](#).

Figure 177: Example H-VPLS Network

H-VPLS spokes allow VPLS domains to be constructed hierarchically in a partial-mesh or hub-and-spoke configuration. This is useful for increasing the scaling of VPLS domains that can be supported. Within the context of H-VPLS, a spoke is a VPLS connection between two VPLS peers. Typically, one *spoke node* provides connectivity to the customer VLAN or customer service while its peer, a *core node*, provides repeater connectivity to other VPLS peers.

The pseudo wire hierarchy must be known because the forwarding rules for spoke and core pseudo wires are different. Flood traffic received on a core pseudo wire from another full-mesh core PE must not be transmitted over other core pseudo wires to other PEs. However, flood traffic received on a core pseudo wire is transmitted on all spoke pseudo wires in the VPLS. Unlike core pseudo wires in full-mesh VPLS, flood traffic received on a spoke pseudo wire must be transmitted on all other pseudo wires in the VPLS, including pseudo wires to other core PEs.

H-VPLS introduces the definition of a *pseudo wire type*. In previous ExtremeXOS releases, only core peers were supported in an interconnected full-mesh configuration. Therefore, all pseudo wires were considered to be of the type core. A new spoke pseudo wire type is introduced and is highlighted in [Figure 177](#). A VPLS core node that has multiple spoke pseudo wires but no configured core pseudo wires is informally referred to as a hub.

The following sections provide additional information on H-VPLS features and operation:

- [Eliminating Packet Replication by the MTU on page 1131](#)
- [Simplifying Customer Service Provisioning on page 1131](#)
- [Redundant Spoke Pseudo Wire Connections on page 1131](#)
- [MAC Address Withdrawal TLV Support on page 1133](#)
- [Event Log Messages on page 1133](#)
- [SNMP Support on page 1133](#)

Eliminating Packet Replication by the MTU

A scaling problem inherent in a full-mesh VPLS network is packet replication. In a full-mesh configuration, until a node learns over which pseudo wire a MAC address is reachable, unknown unicast frames must be flooded on all pseudo wires within the VPLS. Packet replication is always true for broadcast and multicast traffic. As the number of VPLS peers increase, the packet replication burden on a node increases. MTU devices attached to a full-mesh core most likely cannot maintain wire-speed forwarding as the number of VPLS peers increase. Hierarchical VPLS eliminates this MTU burden by requiring only a single pseudo wire connection between a spoke and its core PE peer. Packet replication is pushed to the PEs, where it is more suitably handled.

Simplifying Customer Service Provisioning

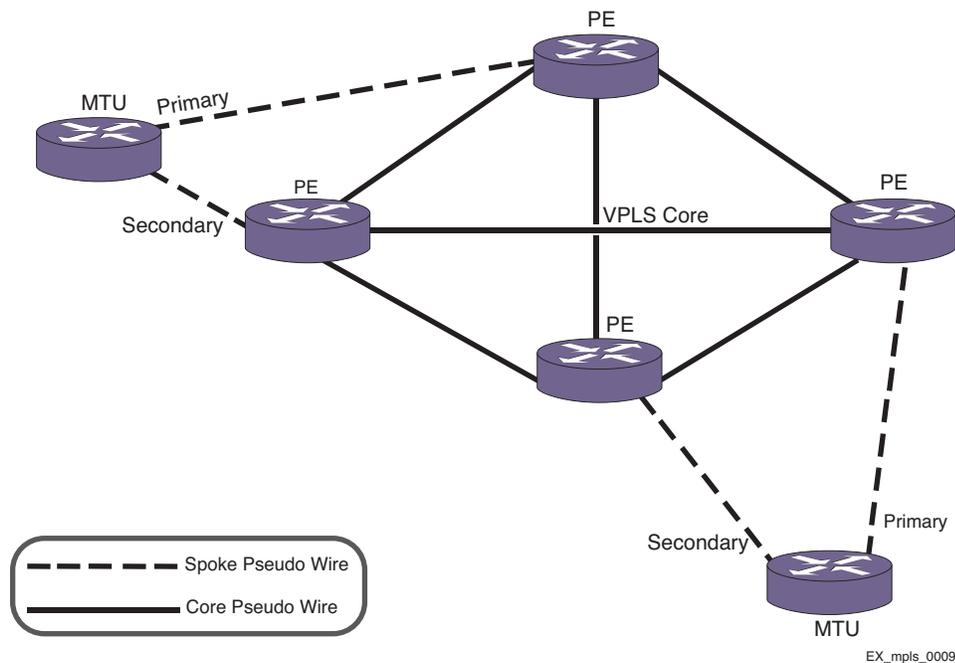
Bandwidth provisioning between an MTU and a PE is extremely difficult with a full-mesh VPLS design. Since each VPLS instance can require multiple tunnel LSPs, the bandwidth requirements for each tunnel LSP must be separately accepted and individually enforced by every PE a tunnel LSP traverses. Since the provider requirement is to manage the provisioned bandwidth for the VPLS and not each tunnel LSP, the MTU has the added responsibility of rate limiting the aggregate egress traffic across multiple tunnel LSPs on the uplink. Due to packet replication issues described previously, this is not practical.

Hierarchical VPLS designs simplify bandwidth provisioning and management. Because tunnel LSPs from the MTU are terminated at the PE, tunnel LSP resources are easily shared and managed between customers. Thus, traffic for multiple VPLS instances can be transported across a single tunnel LSP. In some cases only a single best-effort tunnel LSP is required between the MTU and the PE. Traffic for each customer is carried over a different pseudo wire on the same tunnel LSP. This allows the tunnel LSP to be signaled once, with the desired bandwidth and priority parameters sufficient for providing *best-effort* service for customers connected to the spoke peer. If a customer upgrades their service or a new customer is connected that requires guaranteed bandwidth, a second tunnel LSP could be signaled with the SLA bandwidth parameters. Once established, the second tunnel LSP can carry traffic for a single customer as a premium service.

Redundant Spoke Pseudo Wire Connections

Redundant spoke pseudo wires to PE peers can be configured from a MTU to provide backup connectivity into a VPLS core. The addition of a redundant spoke pseudo wire is optional. By default, the spoke pseudo wire to the primary peer is used to forward packets. In the event of a network failure over the primary pseudo wire, the spoke pseudo wire to the secondary peer is used to provide redundant VPLS connectivity. An example network is shown in [Figure 178](#).

Figure 178: Example H-VPLS Network with Redundant Spokes



When both the primary and secondary pseudo wires are established, the MTU is responsible for *blocking* the secondary pseudo wire. Any packets received on the secondary pseudo wire while the primary pseudo wire is active are discarded. This behavior prevents packet-forwarding loops within the L2 VPN.

Since the MTU is responsible for choosing which pseudo wire to the VPLS is active, the MTU is uniquely responsible for preventing network loops. The MTU uses only one spoke pseudo wire per VPLS and only the label stack associated with the active pseudo wire is programmed into the hardware. If the active pseudo wire fails, then the label stack for the active pseudo wire is removed from hardware. The secondary pseudo wire label stack is then installed in the hardware providing a redundant VPLS link from the MTU into the VPLS core. Customer connectivity through the MTU should experience minimal disruption.

A recent IETF draft has proposed using the Status TLV defined in RFC 4447, *Pseudowire Setup and Maintenance Using the Label Distribution Protocol (LDP)*, to signal that a pseudo wire is actively being used to forward traffic. The draft proposes a new *Active/Standby* bit to indicate that a pseudo wire is operational but is being blocked due to redundancy considerations. Until this proposed encoding progresses in the IETF, the ExtremeXOS software will use the existing *Not Forwarding* bit defined in RFC 4447 to indicate a blocked or standby condition.

When a failover occurs from a primary pseudo wire to a secondary pseudo wire, the spoke node clears its FDB database of MAC addresses learned over the primary pseudo wire. It then begins learning MAC addresses over the new active pseudo wire. To inform its peers to clear their learned MAC database, the PE node can send a *MAC address withdrawal message* (if this feature is enabled) to the other VPLS full-mesh core nodes. Upon receipt of the MAC address withdrawal message, each core node clears its database. In this manner, other core nodes re-learn MAC addresses from the correct pseudo wire or port.

Packets can be received out-of-order by the VPLS destination device during certain pseudo wire failover events. In the redundant VPLS spoke configuration, when a pseudo wire fails, traffic is immediately redirected to the backup or secondary core node. For a very short period of time, there may be transit

packets that are simultaneously in route via both the primary pseudo wire and secondary pseudo wire. No attempt to prevent mis-ordered packets from being received is made.

The command to configure the VPLS peer from an MTU to a PE and from a PE to an MTU is fundamentally the same. However, the optional primary and secondary pseudo wire keywords are only applicable on the MTU since the MTU is responsible for preventing loops within the VPLS. A switch cannot be configured with a primary and a secondary pseudo wire to the same peer within a VPLS. This is an invalid configuration since it provides no redundant protection for a failed PE peer.

MAC Address Withdrawal TLV Support

MAC address withdrawal is a feature that is enabled by default. You can disable this feature. When this feature is disabled, MAC addresses on a failed pseudo wire eventually age out, but it takes the VPLS network longer to adjust than if MAC address withdrawal is enabled. This section describes how this feature operates when it is enabled.

After certain network recovery events, MAC addresses should be unlearned. For example, when an MTU VPLS network facing port goes down, the MTU withdraws the VC FEC label to the PE. The PE, in turn, flushes its FDB of any MAC addresses learned from the MTU and the PE sends an *address-withdraw message* to all VPLS full-mesh core peer PE nodes. The core peer PE nodes must flush their FDB of any matching unlearned MAC address specified in the address-withdraw message regardless of how the MAC was learned. By withdrawing a MAC address immediately, the PE is forced to flood traffic destined to unlearned MAC addresses specified in the address-withdraw message. If an alternate VPLS path exists, the new path is quickly learned without having to wait for the FDB MAC entry to age out.

The address-withdraw message is sent when a spoke pseudo wire terminates to a core VPLS PE node from an MTU. If the MTU has a backup pseudo wire, the MTU sends a MAC address-withdrawal message using the now active backup pseudo wire to the PE. If the VPLS access is protected using a redundant MTU protection scheme and the backup pseudo wire is on the redundant MTU, then the redundant MTU sends a MAC address-withdrawal message using its now active backup pseudo wire to the PE.

When a node needs to withdraw a MAC address, it can signal the MAC withdraw using a withdraw message in one of two ways. The MAC address is explicitly specified in a MAC TLV, or an empty MAC TLV is sent indicating that all MAC addresses for the VPLS have been withdrawn. Because this information must be propagated to all VPLS nodes, a control plane processing trade-off exists. To reduce the processing load on the management module, an empty MAC TLV is sent. This forces all peer PE nodes to flush their MAC FDB for the VPLS specified in the FEC TLV. The control module supports the processing of multiple withdraw messages per VPLS, since other vendors may choose not to implement this optimization.

Event Log Messages

The H-VPLS feature has full EMS logging capabilities to capture error and debug information. Messages are logged with the MPLS component identifier.

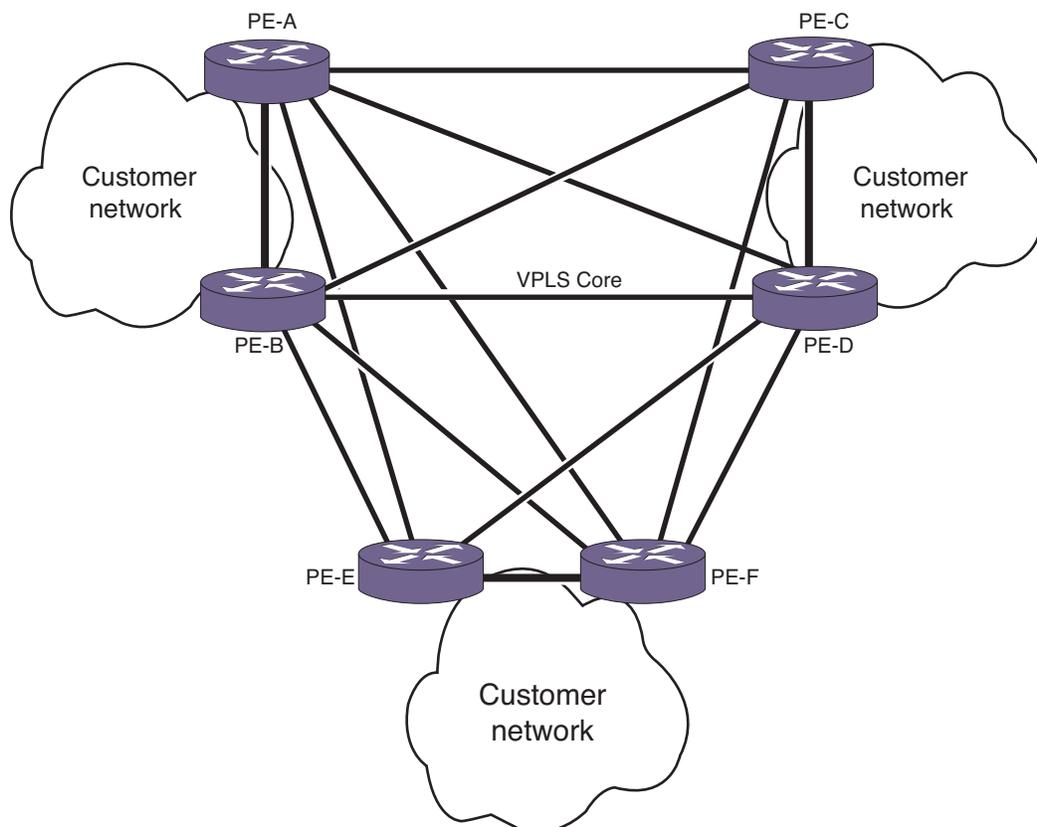
SNMP Support

No SNMP support is provided for H-VPLS.

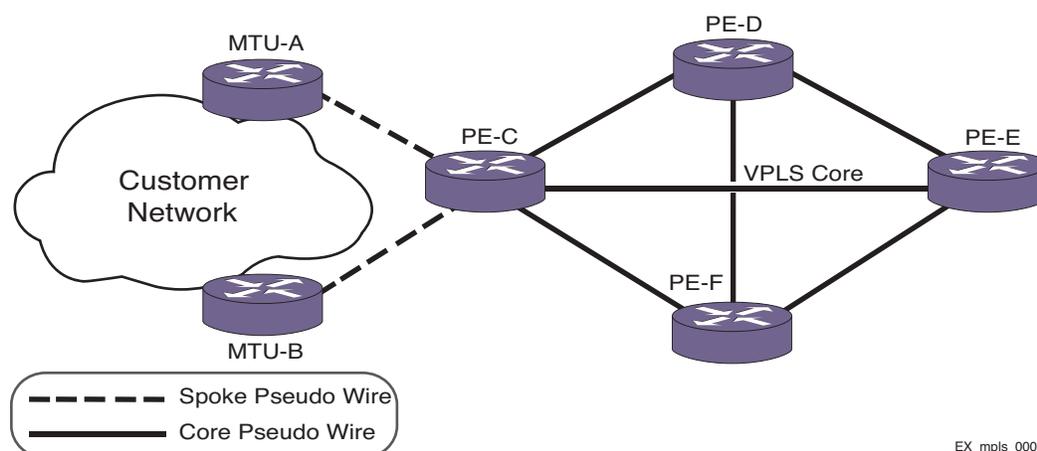
Protected VPLS and H-VPLS with ESRP Redundancy Overview

Protected VPLS Access enables redundant nodes at the entry to a VPLS or H-VPLS network. This feature provides fault tolerant connectivity from the customer VLAN to the backbone VPLS. This could be implemented by running Layer 2 protocols across the VPLS to block switch ports, but this can lead to sub optimal spanning tree topologies across the VPLS backbone and relatively long outages while the STP converges. Instead, the ExtremeXOS software has been enhanced to provide the ability to configure redundant VPLS switches using a dual-homed design that provides fast failover for protected access points. [Figure 179](#) shows fault-tolerant access in a full mesh core VPLS network while [Figure 180](#) shows fault-tolerant access in a hierarchical VPLS network.

Figure 179: Example Protected Access VPLS Network



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Figure 180: Example Protected Access H-VPLS Network

In [Figure 180](#), fault tolerance is provided at the customer site by MTU-A and MTU-B. A failure of either MTU-A or MTU-B does not result in any loss of customer connectivity beyond the failover time from one MTU to the other.

ESRP is employed to ensure that only one VPLS switch is active at any instant in time for a protected customer access point. Only the ESRP master switch forwards packets between the access network and the backbone VPLS network. This active primary switch retains this status based on a set of predefined tracking criteria. If the configured criteria can be better satisfied by the inactive secondary VPLS switch, the primary VPLS switch relinquishes control and the secondary switch assumes the active role. The secondary switch can also autonomously assume the active role if it detects that the primary switch has failed. This use of ESRP helps to prevent duplicate packet delivery and to prevent broadcast loops when the customer network is a loop topology.

The following sections provide additional information on these configurations:

- [Fault Tolerant Access Points Assumptions and Limitations on page 1135](#)
- [H-VPLS Redundant Edge Network on page 1136](#)
- [Fault Tolerant VPLS Operation on page 1136](#)
- [Performance of Fault Tolerant VPLS Access Points on page 1137](#)
- [Deployment and Application Considerations on page 1137](#)
- [Event Log Messages on page 1138](#)
- [SNMP Support on page 1138](#)

Fault Tolerant Access Points Assumptions and Limitations

The following assumptions and limitations are associated with a fault tolerant access point network:

- This feature does not interoperate with the VPLS redundancy feature in ExtremeWare.
- This feature supports a maximum of two (2) redundant VPLS switches per protected VLAN access point.
- This feature operates only with ESRP extended mode.
- For ESRP to communicate between neighbor switches, you must configure a separate control VLAN with the same network layout as the set of protected customer VLANs. For example, consider two customer VLANs, VLAN-X and VLAN-Y. Both require protected VPLS access. If both VLAN-X and VLAN-Y have the same network layout (for example, both are part of a single EAPS domain), you

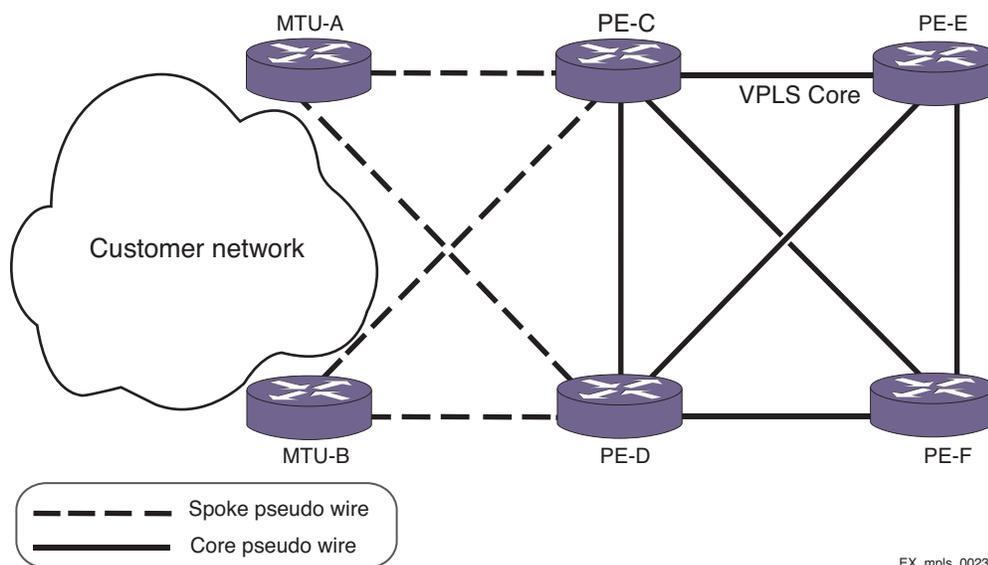
must create an ESRP control VLAN that has the same layout as VLAN-X and VLAN-Y. Conversely, if VLAN-X and VLAN-Y do not have the same layout, you must create two separate ESRP domains with each control VLAN following the layout of the associated service VLAN(s).

- All VPLS switches in the control VLAN need to have the same ESRP domain configured. VPLS switches that provide protected access to the VPLS network need to have ESRP enabled while other nodes in the control VLAN need to be ESRP aware.
- The software does not validate the configuration between switches to determine if all VPLS switches for a protected VLAN are configured to be part of the same ESRP.

H-VPLS Redundant Edge Network

In [Figure 180](#), PE-C still represents a single point of failure. To remove this exposure, the fault tolerant access points shown in [Figure 180](#) can be combined with the redundant spoke pseudo wires shown in [Figure 178](#) to produce a redundant edge configuration as shown in [Figure 181](#).

Figure 181: Example Redundant Edge H-VPLS Network



In the network shown in [Figure 181](#), only one of the pseudo wires between the MTUs and their attaching PEs is active at any instant in time. This network provides fault tolerance for a failure at either MTU or at either of the attaching PEs, as well as for the active pseudo wire in use between the MTUs and PEs.

Fault Tolerant VPLS Operation

To provide the fault tolerance shown in [Figure 179](#) through [Figure 181](#), the redundant network nodes communicate with each other to determine the active primary and inactive secondary status and elect an active master node. For a VPLS domain type, ESRP considers election factors in the following order: stickiness, active ports, tracking information, and ESRP priority. For more information on the ESRP election priority, see [Chapter 28, “ESRP.”](#)

For fault tolerant VPLS to function correctly, the ExtremeXOS software imposes restrictions on the configuration options on the VPLS redundancy type ESRP domain. [Table 114](#) lists the configuration restrictions on the control VLAN.

Table 114: ESRP Configuration Restrictions for VPLS Type Domains

No.	Parameter	Restrictions	Remarks
1	mode	Not configurable	Only extended mode is supported.
2	elrp poll	Always enabled on control VLAN ports	Enabled because control VLANs can have loops. That is, a control VLAN is protecting an S-VLAN in an EAPS ring.
3	master VLAN	No restrictions	The ESRP control VLAN is configured as the master VLAN on the ESRP master and slave.
4	member VLAN	Not configurable	Member VLANs are not configured for the domain since we would need the slave node to perform L2 switching and L3 forwarding.
5	track-environment	Not configurable	Tracking is always done on pseudo wires.
6	track-VLAN	Not configurable	Tracking is always done on pseudo wires.
7	track-IProute	Not configurable	Tracking is always done on pseudo wires.
8	track-Ping	Not configurable	Tracking is always done on pseudo wires.
9	domain-id	None	
10	elrp-master-poll	No restrictions	Disabled by default and can be enabled.
11	elrp-premaster-poll	No restrictions	Disabled by default and can be enabled.
12	election policy	Not configurable	Always set to: <code>ports > track > priority</code> .
13	name	No restrictions	
14	priority	No restrictions	
15	timer	No restrictions	When the service VLAN is part of an EAPS ring, it is strongly recommended that the hello timer is always greater than the EAPS master health checkup timer because an ESRP switch before EAPS could cause traffic loops.

The MTU nodes in [Figure 181](#) signal the PE nodes about active/inactive state using the Status TLV defined in RFC 4447, *Pseudowire Setup and Maintenance Using the Label Distribution Protocol (LDP)*. This operation is described in [“Redundant Spoke Pseudo Wire Connections”](#) on page 1131.

Performance of Fault Tolerant VPLS Access Points

Switching times for a VPLS type ESRP domain are the same as that for regular domains. Actual time depends on the configured hello timer values and is expected to be in the order of seconds.

Deployment and Application Considerations

The following configuration guidelines should be observed when deploying fault tolerant access points:

- When this feature is deployed with EAPS access rings, it is strongly recommended that the EAPS health check time is configured to a value that is less than or equal to the ESRP hello time. Current defaults are 1 second and 2 seconds for EAPS health check and ESRP hello, respectively.
- All nodes in the control VLAN other than the two VPLS enabled nodes are configured as ESRP-Aware.

Event Log Messages

This feature has full EMS logging capabilities to capture error as well as debug information. Messages are logged with the MPLS component identifier.

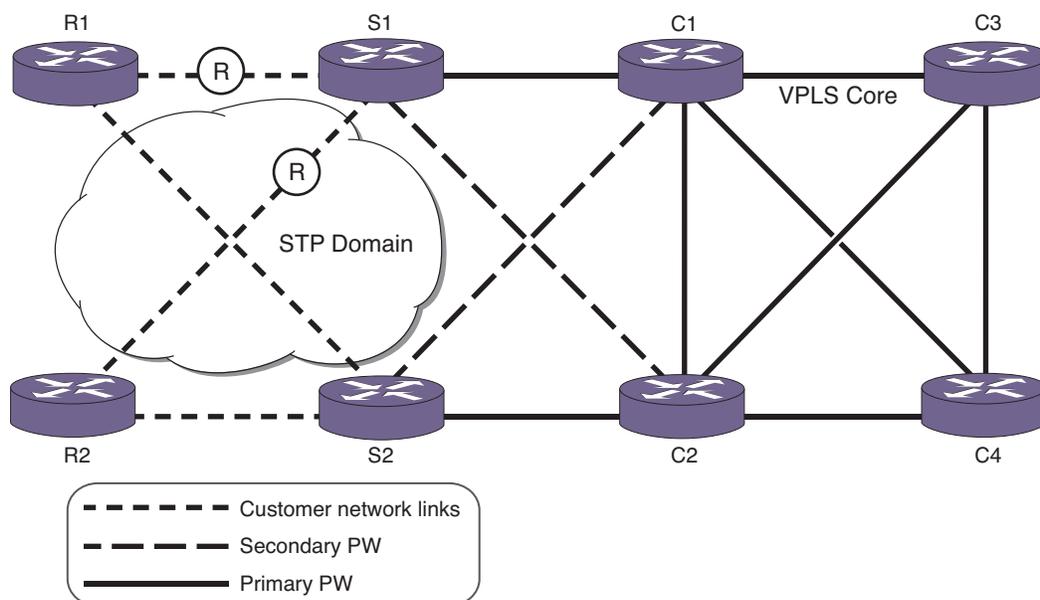
SNMP Support

No SNMP support is provided for protected VPLS access.

VPLS STP Redundancy Overview

Figure 182 shows an example network that uses STP to support redundant links to an H-VPLS network.

Figure 182: Example Redundant Edge H-VPLS Network with STP



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The topology in Figure 182 uses redundant VPLS spoke nodes (S1 and S2) and an STP customer network to protect customer access. The redundant VPLS nodes provide protection from the loss of a VPLS node, and STP provides protection from the loss of a node or link in the customer access network. Within the VPLS nodes, VPLS and STP work together to react to topology changes in the customer access VLAN.

This topology uses the restricted role feature on access switch ports to control path redundancy. In Figure 182, the VPLS nodes S1 and S2 are the lowest priority STP bridges (STP prefers lower priority for root bridge election and shortest path calculation). The S1 ports connected to the R links are configured for STP restricted role mode. To prevent network loops, the restricted role mode in S1 blocks an STP enabled port when STP BPDUs with better information are received from the access network. As shown, the customer traffic uses S2 to access the VPLS network. Should one of the two restricted ports on S1 become unblocked due to a topology change, customer traffic could use both S1 and S2 to access the VPLS network.

The selection of primary and secondary PWs for this configuration is arbitrary. Therefore data paths traversing the spoke nodes S1 or S2 could use either or both core nodes C1 and C2.

In the network shown in [Figure 182](#), traffic destined to R1 from the VPLS core traverses C2, S2, and R1.

The following sections provide more information on VPLS STP redundancy:

- [Failure Recovery Scenario without VPLS STP Redundancy on page 1139](#)
- [Failure Recovery Scenario with VPLS STP Redundancy on page 1139](#)
- [Requirements and Limitations on page 1140](#)
- [Enabling and Disabling VPLS STP Redundancy on page 1140](#)

Failure Recovery Scenario without VPLS STP Redundancy

If VPLS STP redundancy is not configured on the network shown in [Figure 182](#) and the S2-R1 link fails, S1 unblocks S1-R1 and S2 flushes its FDB on the S2-R1 port. The VPLS core nodes C3 and C4 are unaware of this change and continue to forward any traffic destined for R1 to C2. C2 continues to forward traffic towards S2. This results in data loss because S2 is not able to reach R1 over the customer network.

This data loss continues until one of the following events occurs:

- The FDB entry for R1 ages out in the VPLS core nodes
- R1 sends traffic into the VPLS core allowing its MAC address to be relearned by the VPLS core nodes

Depending on the type of data traffic from R1, the latter scenario might not occur quickly.

Failure Recovery Scenario with VPLS STP Redundancy

If VPLS STP redundancy is configured on switches S1 and S2 in [Figure 182](#) and the S2-R1 link fails, S1 unblocks S1-R1 and S2 flushes its FDB on the S2-R1 port. When S2 flushes its FDB, it also sends a flush message to its core peer C2. Upon receipt of this flush message, C2 flushes its FDB entries learned over the PW to S2. C2 also sends flush messages to its core peers C1, C3, and C4. These core nodes then flush their FDB entries learned over their PWs to C2. Any traffic from the VPLS core destined for R1 is flooded until such time as traffic from R1 is forwarded into the VPLS core.



NOTE

In the example shown in [Figure 189](#), the core nodes are unaware that STP redundancy is configured on S1 and S2. There is no STP redundancy configuration on C1 and C2.

[Figure 182](#) shows an H-VPLS configuration where the STP network directly connects to redundant spoke nodes. A similar configuration is possible where the STP network directly connects to redundant VPLS core nodes. In this case, the core nodes participating in STP are configured for STP redundancy and originate flush messages to their core peers whenever STP causes a flush on an STP port.

Requirements and Limitations

The configuration in [Figure 182](#) has the following requirements and limitations:

- The VPLS nodes with STP redundancy (Switches S1 and S2) must always be the lowest priority STP bridges to insure that STP port blocking is done by one of the VPLS nodes. For example, the following priorities for the nodes in [Figure 182](#) will work correctly: S1, priority 8192; S2, priority 4096; R1, priority 32768; and R2, priority 32768.
- For VPLS STP redundancy to work properly, the VPLS nodes must be directly connected to the STP nodes. For example, if a node R3 is added between S2 and R2, node S2 cannot directly detect a failure of the link between R3 and R2.

Enabling and Disabling VPLS STP Redundancy

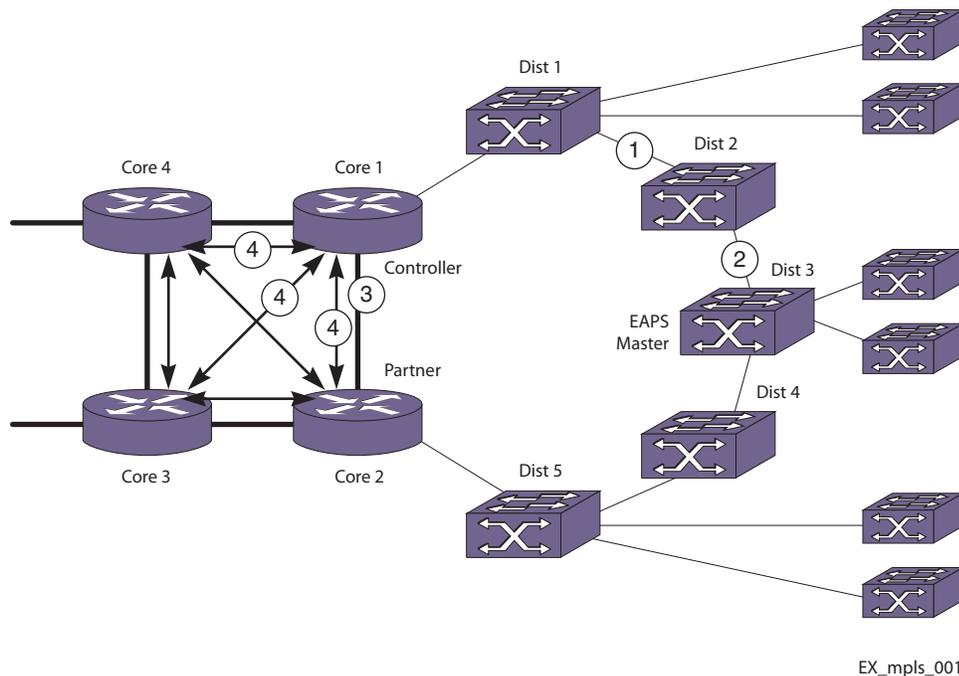
To enable or disable VPLS STP redundancy, use the following commands:

```
configure {l2vpn} vpls <vpls_name> redundancy [esrp <esrpDomain> | eaps | stp]
unconfigure {l2vpn} vpls <vpls_name> redundancy [eaps | esrp | stp]
```

VPLS EAPS Redundancy Overview

To protect your customer access network from link and node failures, you can use the VPLS with Redundant EAPS configuration shown in [Figure 183](#).

Figure 183: VPLS with Redundant EAPS Configuration Example



The topology in [Figure 183](#) uses redundant VPLS core nodes and an EAPS ring to protect customer access. The redundant VPLS nodes provide protection from the loss of a VPLS node, and the EAPS ring provides protection from the loss of a node or link on the EAPS ring. Within the VPLS nodes, VPLS and EAPS work together to control the use of PWs so that no loops are created.

During normal operation, the *Dist2* node is the EAPS ring master, and it blocks the port leading to the link at point 2 in [Figure 183](#). The protected VLANs on the EAPS ring do not include the EAPS common link at point 3 in [Figure 183](#). The protected VLANs on the EAPS ring use VPLS PWs between the redundant VPLS nodes to connect the two ring segments. This difference in normal EAPS operation is established during configuration by configuring an EAPS-protected VLAN on the core node with only one port on the ring.

The following sections provide information about using a VPLS with redundant EAPS configuration:

- [Requirements and Limitations on page 1141](#)
- [Failure Recovery Scenario 1 on page 1141](#)
- [Failure Recovery Scenario 2 on page 1142](#)
- [Failure Recovery Scenario 3 on page 1142](#)

To see the commands used to create the configuration in [Figure 183](#), see “[VPLS with Redundant EAPS Configuration Example](#)” on page 1185.

Requirements and Limitations

The solution in [Figure 183](#) has the following requirements and limitations:

- The redundant VPLS nodes must be core nodes.
- An EAPS common link is required between the redundant VPLS nodes.
- The redundant VPLS nodes (Core 1 and Core 2) use PWs to connect to each other and the other core nodes (Core 3 and Core 4).
- The redundant VPLS nodes use PWs to support the EAPS-protected VLANs, not the EAPS common link.
- Works only with EAPS customer attachment ring.
- The EAPS master should NOT be on a VPLS node.
- EAPS state used by VPLS to control state of PWs (Active/Ready)
- EAPS monitors common link state and ring state
- VPLS on controller node uses EAPS state to set Active/Ready PWs
- EAPS blocks customer-facing ports as normal

Failure Recovery Scenario 1

Suppose that a failure occurs at point 1 in [Figure 183](#). The EAPS master detects the topology change (either through a failure notification from a node on the ring or through a hello timeout), and it unblocks the port on the protected VLAN at point 2. The *Dist 2* node now connects to the VPLS through *Core 2* instead of through *Core 1*.

When the topology changes either on an access ring or the shared port link, the path used to reach customer devices can change. For example, in [Figure 183](#), the path that *Dist 2* takes to reach other parts of the VPLS network changes following the failure on the access ring at point 1. Prior to the failure, *Dist 2* used *Core 1* to reach the VPLS network. Following the failure, *Dist 2* accesses the VPLS network using *Core 2*.

When the EAPS master detects a topology change, it sends a *flush FDB* message to its transit nodes. The transit nodes relearn all the MAC addresses on the ring. However, this *flush FDB* message is not propagated over the VPLS network. As a result, *Core 3* in [Figure 183](#) still expects to find *Dist 2* through

the PW between *Core 3* and *Core 1*. Any traffic destined for *Dist 2* that is sent to *Core 1* will not reach its destination.

To correct this problem, EAPS informs VPLS about any received EAPS *flush FDB* messages on both the controller and the partner nodes, and VPLS performs a local flush of any MAC addresses learned from the originating nodes. In this example, the EAPS processes in both *Core 1* and *Core 2* notify VPLS because neither node knows where the access ring is broken. The VPLS services in *Core 1* and *Core 2* send flush messages to the other VPLS nodes.

Failure Recovery Scenario 2

The recovery scenario is more complicated when the common link fails between *Core 1* and *Core 2*. The common link is configured to be an EAPS common link, and this configuration requires that one node be designated as the EAPS controller node and the other node be designated as the EAPS partner node. As described below, the selection of which node is assigned which role must consider the overall customer topology.

If the shared port link fails, the EAPS master node unblocks its port, and VPLS on the EAPS controller node takes the additional action to remove the PWs (point 4 in [Figure 183](#)) associated with the VPLS from hardware.

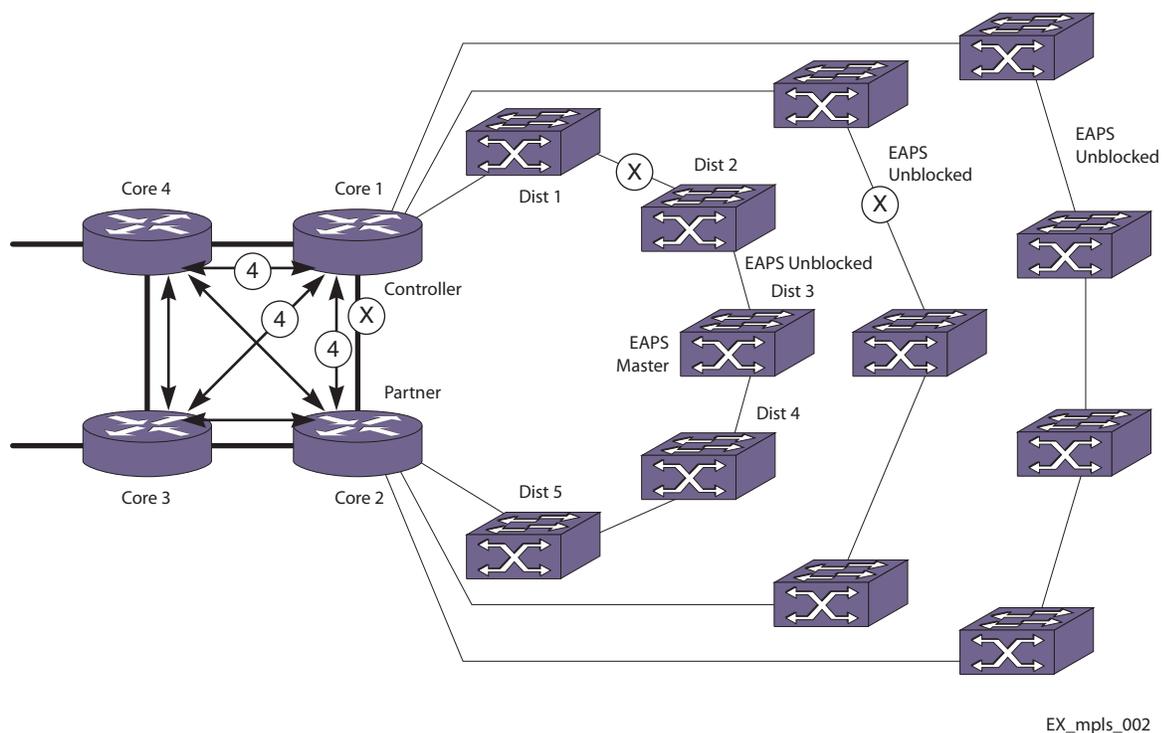
In this recovery mode, all traffic to and from the access ring and the rest of the VPLS instance passes through *Core 2*. When the EAPS controller node detects that the common link is repaired, it enters the *preforwarding state* as normal. When the controller node exits the preforwarding state, EAPS informs VPLS so that VPLS can reestablish the PWs.

Failure Recovery Scenario 3

Now suppose there is a failure on the shared port link (point 3) and on the access ring at point 1. The recovery actions for this double-failure need to be somewhat different. In this case, even though the core link has failed, both core nodes do not receive a copy of the ring traffic. For example, the only path to the VPLS network for *Dist 1* is through the controller core node. In this case, the controller node does not take down its PWs.

It is possible that the customer access network could have parallel EAPS rings that attach to *Core 1* and *Core 2* as shown in [Figure 184](#). In this example, the network connections are broken at each point X and as long as any of the parallel EAPS rings are complete, there is a path to both core VPLS nodes. Thus, the controller node must take down its PWs as long as any of the parallel EAPS rings is complete.

Figure 184: VPLS with Parallel Redundant EAPS Rings Configuration Example



EX_mpls_002

Table 115 shows how the controller node responds to multiple failures in a network with parallel EAPS rings.

Table 115: PW Management for Network Failures

Ring State	Common Link Up	Common Link Down
Any parallel ring Up	PWs Active	PWs Inactive
All parallel rings Down	PWs Active	PWs Active

RSVP-TE Overview

RSVP is a protocol that defines procedures for signaling QoS requirements and reserving the necessary resources for a router to provide a requested service to all nodes along a data path.

RSVP is not a routing protocol. It works in conjunction with unicast and multicast routing protocols. An RSVP process consults a local routing database to obtain routing information. Routing protocols determine where packets get forwarded; RSVP is concerned with the QoS of those packets that are forwarded in accordance with the routing protocol.

Reservation requests for a flow follow the same path through the network as the data comprising the flow. RSVP reservations are unidirectional in nature, and the source initiates the reservation procedure by transmitting a path message containing a traffic specification (Tspec) object. The Tspec describes the source traffic characteristics in terms of peak data rate, average data rate, burst size, and minimum/maximum packet sizes.

RSVP-TE is a set of traffic engineering extensions to RSVP. RSVP-TE extensions enable RSVP use for traffic engineering in MPLS environments. The primary extensions add support for assigning MPLS labels and specifying explicit paths as a sequence of loose and strict routes. These extensions are

supported by including label request and explicit route objects in the path message. A destination responds to a label request by including a label object in its reserve message. Labels are then subsequently assigned at each node the reserve message traverses. Thus, RSVP-TE operates in downstream-on-demand label advertisement mode with ordered LSP control.

The ExtremeXOS software implementation of RSVP-TE complies with RFC 3209 and includes support for:

- Configuration on a per VLAN interface
- Operation as either edge or core MPLS router
- Support for specifying explicitly routed paths
- Support for both loose and strict route objects
- Recording the route of an established path
- Bandwidth reservation and policy per LSP
- Signaling QoS along the RSVP path using the Tspec and Adspec objects
- Fixed Filter (FF) and Shared Explicit (SE) reservation styles
- Specifying RSVP-TE session attributes
- Scaling enhancements using Refresh Overhead Reduction extensions
- Improved link failure detection using the RSVP-TE Hello Message
- Ability to reroute traffic over pre-configured backup LSPs

The following sections provide additional information on RSVP-TE:

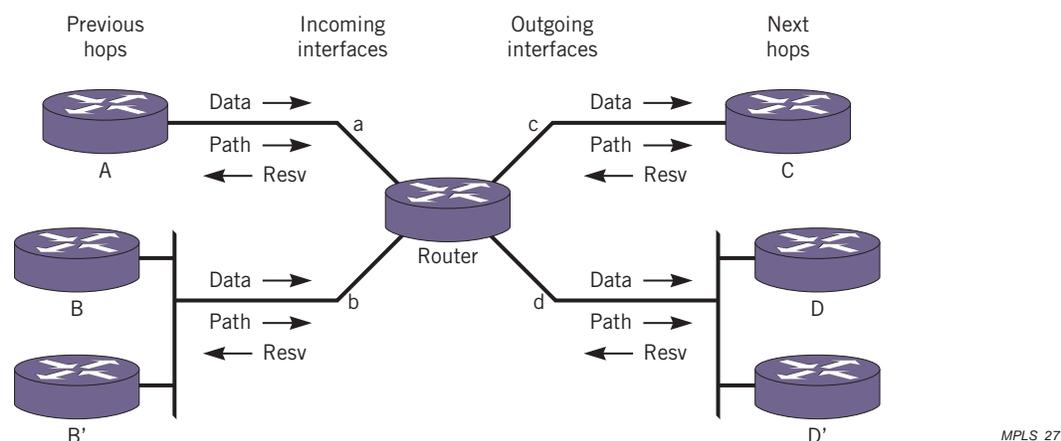
- [RSVP Elements on page 1144](#)
- [RSVP Traffic Engineering on page 1147](#)
- [Establishing RSVP-TE LSPs on page 1149](#)
- [RSVP-TE Implementation on page 1149](#)

RSVP Elements

This section describes the following elements of the RSVP protocol:

- [Message Types on page 1144](#)
- [Reservation Styles on page 1146](#)

Message Types. RSVP messages are passed between RSVP capable routers to establish, remove, and confirm resource reservations along specified paths. RSVP messages are sent as raw IP datagrams with protocol number 46. Each LSR along the path must process RSVP control messages so that it can maintain RSVP session state information. Therefore, most RSVP messages are transmitted with the IP Router Alert Option. Including the IP Router Alert provides a convenient mechanism allowing the IP routing hardware to intercept IP packets destined to a different IP address and deliver them to the RSVP control plane for processing. This is needed to set up and refresh RSVP-TE LSPs that follow an explicitly specified network path and thus may not use the normal routed next hop IP address. RSVP has two basic message types, path message and reserve message, as shown in [Figure 185](#).

Figure 185: RSVP Messages

RSVP has the following message types:

- Path message
- Reserve message
- Path tear message
- Reserve tear message
- Path error message
- Reserve error message
- Reserve confirm message

Path Message: The RSVP path message is used to store state information about each node in the path. Each RSVP sender transmits path messages downstream along routed¹ paths to set up and maintain RSVP sessions. Path messages follow the exact same path as the data flow, creating path states in each LSR along the path. The IP source address of the path message must be an address of the sender it describes and the IP destination address must be the endpoint address for the session. The path message is transmitted with the IP Router Alert option² since each router along the path must process the path message. Each LSR is responsible for refreshing its path status by periodically transmitting a path message to the downstream LSR.

In addition to the previous hop address, the path message contains the sender Tspec and Adspec. The reservation message carries the flowspec.

Reserve Message: Each receiver host transmits an RSVP reservation request to its upstream neighbor. Reserve messages carry reservation requests hop-by-hop along the reverse path. The IP destination address of a reserve message is the unicast address of the previous-hop LSR, obtained from the session's path state. The IP source address is the address of the node that originated the message. The reserve message creates and maintains a reserve state in each node on the path. Each LSR is responsible for refreshing its reserve status by periodically transmitting a reserve message to the upstream LSR.

Reserve messages are eventually delivered to the sender, so that the sender can configure appropriate traffic control parameters for the first hop node.

Path Tear Message: Path tear messages delete path state information reserved along the path. The message is initiated by the path sender or by any LSR in which a path state time-out occurs or an LSP is

1. The routed path may be the best routed path or an explicitly specified routed path using EROs.
2. IP Router Alert option is described in RFC 2113.

preempted (due to bandwidth reservations), and is sent downstream to the session's path endpoint. Path tear messages are transmitted with the IP Router Alert option and are routed exactly the same as path messages. The IP destination address must be the path endpoint and the source IP address must be the sender address obtained from the session's path state for the path that is being torn down.

When a path state is deleted as the result of the path tear message, the related reservation state must also be adjusted to maintain consistency in the node. The adjustment depends on the reservation style.

Reserve Tear Message: Reserve tear messages delete reservation state information. The message is initiated by the path endpoint or any node along the path in which a reservation state has timed out or an LSP is preempted (due to bandwidth reservations), and is sent upstream to the session's path sender. Reserve tear messages are routed exactly the same as reserve messages. The IP destination address of a reserve message is the unicast address of the previous-hop node, obtained from the session's reservation state. The IP source address is the address of the node that originated the message.

If no reservation state matches the reserve tear message, the message is discarded. The reserve tear message can delete any subset of the filter specification in FF-style or SE-style reservation state. Reservation styles are described in [Table 116](#).

Path Error Message: Path error messages are used to report processing errors for path messages. These messages are sent upstream to the sender that issued the path message. The message is routed hop-by-hop using the path state information maintained in each node. Path error messages are informational and do not modify the path state within any node.

Reserve Error Message: Reserve error messages are used to report processing errors for reserve messages. In addition, reserve error messages are used to report the spontaneous disruption of a reservation. Reserve error messages travel downstream to the endpoint of the session. The message is forwarded hop-by-hop using the reservation state information maintained in each node. Reserve error messages are informational and do not modify the reservation state within any node.

Reserve Confirm Message: Reserve confirm messages are optionally transmitted to acknowledge a reservation request. These messages are transmitted from the sender to the endpoint. The destination IP address is the IP address of the endpoint and the source IP address is the address of the sender. Since none of the intermediate path nodes need to process a reserve confirm message, the message is transmitted without the IP Router Alert option.

Reservation Styles. A reservation style is a set of options that is included in the reservation request.

One reservation style concerns how reservations requested by different senders within the same session are handled. This type of reservation style is handled in one of two ways: either create a *distinct* reservation for each sender in the session, or use a single reservation that is *shared* among all packets of the selected senders.

Another reservation style concerns how senders are selected. Again, there are two choices: an *explicit* list of all selected senders or a *wildcard* that implies all senders in the session.

[Table 116](#) describes the relationship between reservation attributes and styles.

Table 116: Reservation Attributes and Styles

Sender Selection	Distinct Reservation Style	Shared Reservation Style
Explicit	Fixed filter (FF)	Shared explicit (SE)
Wildcard	Not defined	Wildcard filter (WF)

Fixed Filter: The fixed filter (FF) reservation style uses a distinct reservation and an explicit sender selection. This means that each resource reservation is for a specific sender. The session resources are not shared with other sender's packets. Because each reservation is identified with a single sender, a unique label is assigned by the endpoint to each sender (i.e., point-to-point LSP reservation).

Shared Explicit: The shared explicit (SE) reservation style uses a shared reservation and an explicit sender selection. This means that a single resource reservation is created that is shared by multiple senders. The endpoint may specify which senders are to be included for the reservation. Because different senders are explicitly listed in the RESV message, different labels may be assigned to each sender. Thus, multiple shared-resource LSPs to the same endpoint can be created (i.e., multipoint-to-point LSP reservation). The Extreme MPLS implementation requests SE reservation style when signaling RSVP-TE LSPs.

Wildcard: The wildcard (WF) reservation style uses the shared reservation and wildcard sender options. A wildcard reservation creates a single reservation that is shared by data flows from all upstream senders.

The Extreme MPLS implementation does not support WF reservation style.

RSVP Traffic Engineering

MPLS Traffic Engineering (TE) extends RSVP to support several unique capabilities. By coupling RSVP and MPLS, LSPs can be signaled along explicit paths with specific resource reservations. Additional RSVP objects have been defined to provide TE extensions. These objects include the Label Request, Label, Explicit Route, Record Route, and Session Attribute. Extreme's RSVP-TE implementation supports all of these TE objects.

The following sections discuss the implementation of RSVP-TE for the ExtremeXOS software:

- [RSVP Tunneling on page 1147](#)
- [RSVP Objects on page 1148](#)

RSVP Tunneling. An RSVP tunnel sends traffic from an ingress node through an LSP. The traffic that flows through the LSP is opaque (or tunneled) to the intermediate nodes along the path. Traffic flowing through the tunnel to an intermediate node along the path is identified by the previous hop and is forwarded, based on the label value(s), to the downstream node.

RSVP-TE can:

- Establish tunnels with or without QoS requirements.
- Dynamically reroute an established tunnel.
- Observe the actual route traversed by a tunnel.
- Identify and diagnose tunnels.
- Use administrative policy control to preempt an established tunnel.
- Perform downstream-on-demand label allocation, distribution, and binding.

Some LSRs require their neighboring LSRs to include their Router ID in the Extended Tunnel ID field when sending RSVP-TE messages. The Extended Tunnel ID is a globally unique identifier present in the RSVP common header Session object (see RFC 3209). To provide maximum compatibility with other vendors' implementations, the ExtremeXOS MPLS implementation accepts RSVP-TE messages regardless of the Extended Tunnel ID value and always inserts the local Router ID into the Extended Tunnel ID field prior to transmission of an RSVP-TE message.

RSVP Objects. This section describes the RSVP objects that are used to establish RSVP-TE LSPs:

- Label
- Label request
- Explicit
- Record route
- Session attribute

Label: The label object is carried in the reserve message and is used to communicate a next hop label for the requested tunnel endpoint IP address upstream towards the sender.

Label Request: To create an RSVP-TE LSP, the sender on the MPLS path creates an RSVP path message and inserts the label request object into the path message.

A label request object specifies that a label binding for the tunneled path is requested. It also provides information about the network layer protocol that is carried by the tunnel. The network layer protocol sent through a tunnel is not assumed to be IP and cannot be deduced from the Layer 2 protocol header, which simply identifies the higher layer protocol as MPLS. Therefore, the Layer 3 Protocol ID (PID) value must be set in the Label Request Object, so that the egress node can properly handle the tunneled data.



NOTE

The ExtremeXOS RSVP-TE implementation supports only Label Request objects with no Label Range. Label Ranges are used to signal ATM VPI/VCI or Frame Relay DLCI information for the LSP. These types of Label Requests are not supported. In the ExtremeXOS RSVP-TE implementation the L3 PID value, which identifies the Layer 3 protocol of the encapsulated traffic, is always set to 0x0800 (IP).

Explicit Route: The explicit route object specifies the route of the traffic as a sequence of nodes. Nodes may be loosely or strictly specified.

The explicit route object is used by the MPLS sender if the sender knows about a route that:

- Has a high likelihood of meeting the QoS requirements of the tunnel
- Uses the network resources efficiently
- Satisfies policy criteria

If any of the above criteria are met, the sender can decide to use the explicit route for some or all of its sessions. To do this, the sender node adds an explicit route object to the path message.

After the session has been established, the sender node can dynamically reroute the session (if, for example, it discovers a better route) by changing the explicit route object.

Record Route: The record route object is used by the sender to receive information about the actual route traversed by the RSVP-TE LSP. It is also used by the sender to request notification if there are changes to the routing path. Intermediate or transit nodes can optionally use the RRO to provide loop detection.

To use the object, the sender adds the record route object to the path message.

Session Attribute: The session attribute object can also be added to the path message. It is used for identifying and diagnosing the session. The session attribute includes the following information:

- Setup and hold priorities
- Resource affinities
- Local protection

Establishing RSVP-TE LSPs

Establishing LSPs requires every LSR along the path to support RSVP and the Traffic Engineering (TE) extensions defined in RFC 3209. The LSP endpoints attempt to detect non-RSVP capable LSRs by comparing the time-to-live (TTL) value maintained in the RSVP common header with that of the IP TTL. If these values are different, it is assumed that a non-RSVP capable LSR exists along the path. By including the Label Request object in the path message, RSVP capable routers that do not support the TE extensions can be detected. RSVP routers that do not support TE extensions reply with the *Unknown object class* error.

RSVP-TE LSPs are referred to as named LSPs. These LSPs have configurable names that are used to identify the LSP within the CLI. The command `create mpls rsvp-te lsp <lsp_name> destination <ipaddress>` allocates the internal resources for the LSP. The newly created LSP is not signaled until the LSP has been configured. The LSP can be configured to take a specific path through the network or the administrator can let the switch choose the best path by specifying the path *any*. Up to three paths may be configured for an LSP to provide redundancy. The command `configure mpls rsvp-te lsp <lsp_name> add path` configures an LSP. Optionally, RSVP-TE profiles may be applied to an LSP to change its properties. An RSVP-TE profile is a specific CLI container used to hold configuration parameters associated with timers, bandwidth reservation, limits, and other miscellaneous properties.

Once the RSVP-TE LSP is configured, the LSP is immediately signaled. If signaled successfully, the LSP becomes active. The commands `disable mpls rsvp-te lsp <lsp_name>` and `enable mpls rsvp-te lsp <lsp_name>` are used to tear down and re-signal the LSP. Disabling the LSP causes the LER to send a path tear message to the destination, forcing the LSP down and all resources along the path to be freed. Enabling the LSP instructs the LER to send a path message to the destination re-establishing the LSP. The configuration of the LSP is not modified by the *enable* or *disable* LSP commands.

RSVP-TE Implementation

This section covers the following features of RSVP:

- [Explicit Route Path LSPs on page 1149](#)
- [Route Recording on page 1150](#)
- [LSP Session Attributes on page 1151](#)
- [Bandwidth Reservation on page 1151](#)
- [Bandwidth Management for RSVP-TE LSPs on page 1152](#)
- [Redundant LSPs on page 1153](#)
- [Improving LSP Scaling on page 1155](#)

Explicit Route Path LSPs. An explicit route is a specified path through a routed network topology. The path can be strictly or loosely specified. If strictly specified, each node or group of nodes along the path must be configured. Thus, no deviation from the specified path is allowed.

Loosely specified paths allow for local flexibility in fulfilling the requested path to the destination. This feature allows for significant leeway by the LSR in choosing the next hop when incomplete information

about the details of the path is generated by the LER. Each node along the path may use other metrics to pick the next hop along the path, such as bandwidth available, class of service, or link cost. The command `configure mpls rsvp-te path <path_name> add ero` is used to add an Explicit Route Object to a path container.

An explicit routed path is encoded using the explicit route object (ERO) and is transmitted in the path message. The ERO consists of a list of subobjects, each of which describes an abstract node. By definition, an abstract node can be an IP prefix or an autonomous system (AS) number. The ExtremeXOS RSVP-TE implementation supports only IPv4 abstract nodes. The ExtremeXOS RSVP-TE implementation supports both strict and loose IPv4 abstract nodes. Received path messages with EROs that contain any other subobject type result in the transmittal of an *Unknown object class* error message. All LSRs along the specified path must support the inclusion of the ERO in the path message for an explicitly routed path to be successfully set up.

An LSR receiving a path message containing an ERO must determine the next hop for this path. The steps for selection of the next hop are as follows:

- 1 The receiving LSR evaluates the first subobject. If the subobject type is not supported or there is no subobject, a *Bad ERO* error is returned. The abstract node is evaluated to ensure that this LSR was the valid next hop for the path message. If the subobject is a strict abstract node, the abstract node definition must match the local interface address. If it does, then this LSR is considered to be a member of the abstract node. Additionally, if the /32 address matches a local interface address, the path message must have been received on the direct interface corresponding to the /32 address. If the abstract node is an IP prefix, the subnet configured for the interface from which the path message was received must match the abstract node definition. In the event that this LSR is not part of the strict abstract node definition, a *Bad initial subobject* error is returned. If the subobject is a loose abstract node, the LSR determines if the abstract node definition corresponds to this LSR. If it doesn't, the path message is transmitted along the best-routed or constrained optimized path to the endpoint and the ERO is not modified. If it is, then processing of the ERO continues.
- 2 If there is no second subobject, the ERO is removed from the path message. If this LSR is not the end of the path, the next hop is determined by the constrained optimized path (through Constrained Shortest Path First—CSPF) to the path message endpoint.
- 3 If there is a second subobject, a check is made to determine if this LSR is a member of the abstract node. If it is, the first subobject is deleted and the second subobject becomes the first subobject. This process is repeated until either there is only one subobject or this LSR is not a member of the abstract node as defined by the second subobject. Processing of the ERO is then repeated with step 2. By repeating steps 2 and 3, any redundant subobjects that are part of this LSRs abstract node can be removed from the ERO. If this operation were not performed, the next hop LSR might reject the path message.
- 4 The LSR uses its CSPF to determine the next hop to the second subobject. If the first object is a /32 address, the first subobject is removed, since it would not be part of the next hop's abstract node. The path message is then sent along the explicit path to the path message endpoint. No determination is made to verify that the abstract node defined in the subobject is topologically adjacent to this LSR. The next hop should verify this as part of its processing as defined in step 1.

If CSPF determines that a specific path needs to be taken through the network, additional EROs are inserted into the path message.

Route Recording. The route a path takes can be recorded. Recording the path allows the ingress LER to know, on a hop-by-hop basis, which LSRs the path traverses. Knowing the actual path of an LSP can be especially useful for diagnosing various network issues.

Network path recording is configurable per LSP. This feature is configured by enabling route recording for a specific RSVP-TE *profile* using the command `configure mpls rsvp-te lsp profile`

<lsp_profile_name> record enabled and associating the profile to an LSP. The ExtremeXOS software sets the *label recording desired* flag in the path message if route recording has been enabled for the LSP.

If route recording is enabled, the record route object (RRO) is inserted into the path message using a single RRO subobject, representing the ingress LER. When a path message that contains an RRO is received by an Extreme LSR, an RRO IPv4 subobject representing the /32 address of the outgoing interface of the path message is pushed onto the top¹ of the first RRO. The updated RRO is returned in the reserve message.

The *label recording* flag is supported by the ExtremeXOS software and is set automatically when route recording is enabled. The `route-only` option can be used when enabling route recording in the profile to prevent the label recording flag from being set. If an Extreme LSR receives a path message with the label recording flag set in the RRO, the LSR encodes the LSP label into a *label* subobject and pushes it onto the RRO.

If a path message is received that contains an RRO, the Extreme LSR uses the RRO to perform loop detection. The RRO is scanned to verify that the path message has not already traversed this LSR. If the RRO contains an IPv4 subobject that represents a local LSR interface, the path message is dropped and a *Routing Problem* error message is sent to the originating LER with an error value of *Loop detected*.

LSP Session Attributes. Session attributes are signaled for configured RSVP-TE LSPs using the *session attribute* object without resource affinities (that is, LSP_TUNNEL Type). The ExtremeXOS software uses the *setup* and *hold priority* values to preempt established LSPs in order to satisfy bandwidth requests. Lower hold priority LSPs are preempted in order to satisfy the bandwidth request in a path message with a higher setup priority. LSP attributes are configured by setting the priorities for a specific RSVP-TE profile using the command `configure mpls rsvp-te lsp profile <lsp_profile_name> setup-priority <priority> hold-priority <priority>` and associating the profile to the configured LSP.

Bandwidth Reservation. As mentioned previously, RSVP reservations are unidirectional in nature. The source initiates the reservation procedure by transmitting a path message containing a sender Tspec object. The Tspec describes the source traffic characteristics in terms of peak data rate, average data rate, burst size, and minimum/maximum packet sizes. The path message can also contain an optional AdSpec object that is updated by network elements along the path to indicate information such as the availability of particular QoS services, the maximum bandwidth available along the path, the minimum path latency, and the path maximum transmission unit (MTU).

The ExtremeXOS software supports LSR bandwidth reservation requests per LSP. Only the Int-Serv Controlled-Load service request is supported. Bandwidth is always reserved on the physical ports that the LSP traverses. Depending on the platform, the bandwidth reservation may also be policed. The network administrator can verify that the requested bandwidth was actually reserved. In those cases when the bandwidth reserved is less than the requested bandwidth, the LSP can be manually torn down, re-signaled using a different path, or accepted. The LSR automatically attempts to find a path that best satisfies the bandwidth request. Constrained path selections are supported using OSPF-TE. Best effort LSPs are provisioned by specifying a reserved bandwidth as best-effort. The reserved LSP bandwidth is configured by setting the bps rate for a specific RSVP-TE profile, using the `configure mpls rsvp-te lsp profile <lsp_profile_name> bandwidth` command and associating the profile to an LSP.

Accounting of bandwidth reserved through an Extreme LSR RSVP-TE enabled VLAN is supported. The maximum available bandwidth per physical port or trunk group is enforced. Thus, the available

1. RRO is organized as a LIFO stack.

bandwidth specified in the Adspec object is not modified as the path message is forwarded to the LSP endpoint. As reserve messages are processed, the reserved bandwidth specified in the Flowspec is added to the total reserved bandwidth allocated for the physical ports.

Because LSP bandwidth is dynamically allocated, a configuration command is provided to reserve port bandwidth for use by MPLS. The command `configure mpls rsvp-te bandwidth committed-rate` pre-reserves bandwidth from the specified MPLS enabled VLAN for RSVP-TE traffic only. This pre-allocation of bandwidth is useful since other applications may compete with MPLS for available bandwidth. By pre-reserving a portion of the MPLS interface's bandwidth capacity, MPLS is guaranteed to have that amount of the MPLS interface's bandwidth to meet RSVP-TE LSP reservation requests.

CIR bandwidth for the receive direction is not tracked by TE IGP, such as OSPF-TE, and configuring it is not required. Configuring CIR bandwidth for the receive direction does not prevent an LSP from going operational due to lack of receive bandwidth; however, it can be useful for tracking and informational purposes. An Info level log (MPLS.RSVPTE.IfRxBwdthExcd) is generated if the setup of a TE LSP requires receive bandwidth greater than that which is currently available for the receive direction on a particular interface. This generally happens only when TE LSPs with different previous hops ingress the switch on the same interface (for example, from a multi-access link) and egress the switch on different interfaces.

Bandwidth Management for RSVP-TE LSPs. If an RSVP-TE LSP is signaled through a switch with bandwidth parameters, the LSP bandwidth request is granted or rejected based on the availability of bandwidth resources on the physical ports that the LSP traverses. Data traffic through these switches is not policed and there are no guarantees that the packets using the LSP are not dropped.

**NOTE**

Per LSP rate limiting is not supported in this release.

The available bandwidth for each OSPF interface is continually updated within the OSPF area. As RSVP-TE LSPs are established and torn down, the reserved bandwidth associated with these LSPs is used to update the total bandwidth available through each OSPF interface. RSVP-TE and CSPF can use the bandwidth information to determine the appropriate path that each LSP should take through the network based on the LSP's profile parameters. LSP parameters that can affect the CSPF TE path calculation include the LSP setup priority and bandwidth configuration.

Available bandwidth is calculated for eight CoS levels. Each CoS uniquely maps to an LSP hold priority. Thus, when an LSP is set up through the switch, the reserved bandwidth consumed is associated with a CoS based on the signaled LSP hold priority. The available bandwidth is recalculated and is advertised to its OSPF neighbors. Advertised bandwidth is calculated using graduated bandwidth reporting methodology. Using this scheme, higher CoS levels advertise available bandwidth that includes allocated bandwidth for lower CoS levels. The reasoning for doing this is that higher priority LSPs can preempt lower priority LSP. Thus, even though the bandwidth has been allocated to a lower priority LSP, it is still available for use by higher priority LSPs.

In the following example, an interface is configured to reserve 250 Mbps for MPLS traffic. The following LSPs are established through this interface. Remember, hold priority value of 0 is the highest priority and 7 is the lowest.

- LSP A, hold priority = 7, reserved = 50 Mbps
- LSP B, hold priority = 5, reserved = 100 Mbps
- LSP C, hold priority = 2, reserved = 25 Mbps
- LSP D, hold priority = 1, reserved = 25 Mbps

OSPF advertises the following available bandwidth for each CoS. CoS 0 is the highest and CoS 7 is the lowest:

- CoS 0 (hold = 0): 250 Mbps (No LSPs; all bandwidth available)
- CoS 1 (hold = 1): 225 Mbps (LSP D)
- CoS 2 (hold = 2): 200 Mbps (LSP C & D)
- CoS 3 (hold = 3): 200 Mbps (LSP C & D)
- CoS 4 (hold = 4): 200 Mbps (LSP C & D)
- CoS 5 (hold = 5): 100 Mbps (LSP B, C & D)
- CoS 6 (hold = 6): 100 Mbps (LSP B, C & D)
- CoS 7 (hold = 7): 50 Mbps (LSP A, B, C & D)

CSPF calculations only use the available bandwidth for the desired CoS, as specified by the LSP hold priority. Thus in this example, if LSP E, with a configured setup priority of 6, requires 150Mbps, CSPF calculates a path to the destination that does not go through the above interface, since only 100Mbps worth of bandwidth is available.

Redundant LSPs. There are three methods for provisioning redundant RSVP-TE LSPs at the ingress LER, also referred to as head-end LSP protection:

- Configured secondary (or backup) LSPs
- Fast reroute (detour) LSPs
- Multipath LSPs

Secondary RSVP-TE LSPs can be configured to provide backup LSPs in the event that the primary LSP fails. You can create up to two secondary LSPs for each primary LSP. The secondary LSPs are fully provisioned, pre-established RSVP-TE LSPs that are maintained as inactive until needed. If the primary LSP is torn down, the associated LSP next hop is removed from the route table, and a new LSP next hop representing one of the secondary LSPs is installed as the preferred LSP. If there are multiple secondary LSPs available, the secondary LSP is randomly selected. If the primary LSP is re-established, the primary LSP next hop information is re-installed and the secondary LSP returns to inactive state.

If both the primary and secondary paths for an LSP fail, and there are no other RSVP-TE LSPs active to the destination, an LDP LSP can be used if available.

Operation with L2 VPNs is similar. If a primary path fails, and a secondary LSP is available, VPLS uses the secondary LSP. When the primary LSP is re-established, VPLS again uses the primary LSP.

Specifying redundant LSPs is accomplished by assigning secondary paths to an LSP. The `configure mpls rsvp-te lsp <lsp_name> add path <path_name>` command can configure the specified path as a backup LSP. A path different from the primary path must be specified. It is recommended that defined paths be configured using EROs to specify different paths through the network. Relying on the routing topology, by configuring the path to *any*, can create two LSPs that take the same path. It is important to understand that the configured LSP signals multiple LSPs, up to three (one primary and two secondary), but only one LSP can be used to forward traffic at any one time.

Fast Reroute LSPs are based on the on IETF RFC 4090, *Fast Reroute Extensions to RSVP-TE for LSP Tunnels*, which defines RSVP-TE extensions to establish backup LSP tunnels for local repair of LSP tunnels. To respond to failures, these mechanisms enable the re-direction of traffic onto backup LSP tunnels in tens of milliseconds, and this meets the needs of real-time applications such as voice over IP (VoIP). This timing requirement is satisfied by computing and signaling backup LSP tunnels in advance of a failure and by re-directing traffic as close to the failure point as possible. In this way the time for redirection includes no path computation and no signaling delays, which include delays to propagate failure

notification between label-switched routers (LSRs). Speed of repair is the primary advantage of using fast-reroute backup methods.

There are two backup methods; the *detour LSP* method (which is also called the *one-to-one backup* method) and the *facility backup* method (which is also called the *by-pass tunnel* method). The software supports only the detour LSP method.

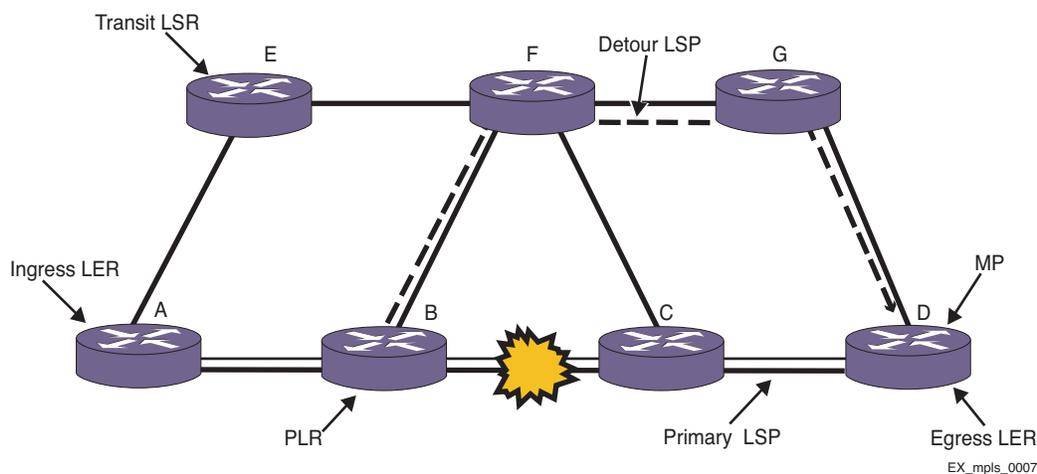
Based on the RFC-4090 there are two different methods to uniquely identify a backup path:

- 1 Path-specific method
- 2 Sender template-specific method

The software supports only the path-specific method, which uses a new object, the DETOUR object, to distinguish between PATH messages for a backup path and the protected LSP.

Figure 186 illustrates the terminology used to describe fast-reroute configuration and operation.

Figure 186: Fast-Reroute Terminology



The primary LSP in Figure 186 is established between MPLS routers A and D. Router A is the ingress LER, and Router D is the egress LER. When used with fast-reroute protection, the primary LSP is also called the *protected LSP*, as it is protected by the *detour LSP* created by the fast-reroute feature. The detour LSP provides a route around a protected component. In Figure 186, the link between Router B and Router C has failed. The detour LSP, which is indicated by the dashed line, provides a path around the failure.

Routers B and C are transit LSRs for the primary LSP. With respect to a specific LSP, any router that is not the ingress or egress LER is a transit LSR. Routers F and G are transit LSRs for the detour LSP.

The origin of the detour LSP is called the Point of Local Repair (PLR), and the termination of the detour LSP is called the Merge Point. A protected LSP is an explicitly-routed LSP that is provided with protection. A detour LSP is also an explicitly-routed LSP. If you configure a series of one or more hops (EROs), then based on the currently set DYNAMIC_FULL option in the Constrained-based Shorted Path First (CSPF) routing component, the CSPF will calculate and try to fill in the gaps to build a complete list of EROs.

You can configure up to two secondary LSPs for each standard TE (non-FRR) LSP or for each protected FRR LSP. If a standard TE LSP fails, then one of the secondary LSPs becomes active. If that secondary LSP fails, the other secondary LSP becomes active. If a protected FRR LSP fails, its detour LSP becomes active. If the detour LSP fails, then one of the secondary LSPs becomes active, and if that secondary LSP

fails, the other secondary LSP becomes active. If all configured backup and secondary paths for an LSP fail, a different active RSVP-TE LSP to the destination can be used. Otherwise, an LDP LSP can be used if available.

The primary advantage of detour LSPs is the repair speed. The cost of detour LSPs is resources. Each backup LSP reserves resources that cannot be used by other LSPs. Another cost is that currently there is no automatic way to redirect traffic from a detour LSP back to a primary LSP when the protected LSP recovers. Redirecting traffic from the detour LSP to the primary LSP requires a series of CLI commands.

Fast reroute protection is configured primarily on the ingress LER, however, it must be enabled on all transit LSRs and the egress LER also. After configuration is complete and fast-reroute protection is enabled on the primary LSP, the primary and detour LSPs are signalled. Provided that the resources are available, detour LSPs are set up at each transit LSP along the primary LSP.

Multiple RSVP-TE LSPs can exist or be configured to the same destination. The paths do not need to be equal cost; all that is required is that all the LSPs to the same destination must have IP transport enabled. In this scenario, LSP next hop information is communicated to the route table for up to eight different named RSVP-TE LSPs. Locally originated traffic is distributed across each LSP based on standard IP address hash algorithms. If one of the LSPs fails, the traffic is redistributed across the remaining active named LSPs. Unlike the backup LSP mechanism, all of the redundant multipath LSPs are unique named LSPs and in general have primary configured paths.

Improving LSP Scaling. RSVP maintains path and reserve state by periodically sending refresh messages. Refresh messages allow each LSR along the path to properly maintain reservation state information and to recover from network failures. Because refresh messages are periodically sent for each path reservation, scaling the number of RSVP-TE LSPs is an issue. Additionally, network requirements for faster failure detection and improved LSP recovery times further exacerbate the scaling issue.

Several techniques are described in *RFC 2961 RSVP Refresh Overhead Reduction* to improve the scalability of RSVP. These techniques include the *bundle message*, *message ID extension*, and *summary refresh extension*. Support for these extensions is signaled between RSVP peers via the *refresh-reduction-capable* bit in the *flags* field of the common RSVP header. Additionally, the *hello extension*, described in RFC 3209, provides a fourth scaling mechanism for RSVP. The *hello extension* is designed so that either peer can use the mechanism regardless of how the other peer is configured. Therefore, support for the *hello extension* is not signaled between RSVP peers. The ExtremeXOS software supports and is compliant with the RSVP-TE scaling features described in RFC 2961.

These features include the following:

- Bundle message
- Summary refresh extension
- Message ID extension
- Hello extension

Bundle Message: RSVP bundle messages aggregate multiple RSVP messages within a single PDU. The messages are addressed directly to peer LSRs. Therefore, bundle messages are not sent with the IP Router Alert option. Bundling multiple RSVP messages into a single PDU reduces the per packet overhead associated with local delivery and local origination. Each bundle message must contain at least one RSVP message. Transmission of RSVP messages may be delayed up to the number of seconds configured for *bundle time*. The size of the bundle message is limited to the RSVP-TE interface MTU size. Bundle messaging is enabled using the `enable mpls rsvp-te bundle-message` command.

Summary Refresh Extension: A summary refresh message is used to refresh RSVP states along an LSP without having to explicitly send path and reserve refresh messages. This can substantially reduce the RSVP control bandwidth overhead. Summary refresh messages contain a list of message_ID objects. Each message_ID object identifies a path and reserve state to be refreshed. When summary refresh support is enabled, path and reserve refresh messages are suppressed. If the message identifier value indicates that the RSVP state has changed, the receiving LSR notifies the sender by transmitting a message_ID_NACK message. The summary refresh rate is enabled using the `enable mpls rsvp-te summary-refresh` command.

Message ID Extension: The message ID extension provides reliable delivery of RSVP messages. It also provides a simple mechanism for identifying refresh messages, which can greatly reduce refresh message processing on the receiving LSR. The message ID extension defines three new objects: message_ID, message_ID_ACK, and message_ID_NACK. The message_ID object contains a unique message identifier based on the sender's IP address. Only one message_ID object is inserted into an RSVP message. The receiving LSR can use the message_ID object to quickly refresh path and reserve states. If the message identifier value in the message_ID object is greater than the locally saved message identifier value, then the RSVP message represents a new or modified state. The receiving LSR must acknowledge an RSVP message using the message_ID_ACK object if the sender set the ACK_desired flag in the message_ID object, otherwise the message_ID acknowledgement is optional. The message_ID_ACK object may be included in any unrelated RSVP message or in an RSVP ACK message. Message ID extension is required for both bundle message and summary refresh, so this capability is automatically enabled if either of the other capabilities is enabled.

Hello Extension: The RSVP hello message provides a quick and simple mechanism for detecting the loss of a peer RSVP-TE LSR. The hello protocol is implemented using the RSVP soft-state model. RSVP hello messages may be enabled independently of each LSR peer. The hello protocol consists of two new objects: hello_request and hello_ACK. If configured, an LSR sends a hello_request every hello interval. If a hello_ACK is not received within a specified amount of time, the sending LSR assumes that its peer LSR is no longer active. Once a peer LSR is deemed inactive, all reservation states associated with LSPs established to or through the peer LSR must be freed and the LSPs torn down. The hello interval is configurable using the command `configure mpls rsvp-te timers session hello-time`.

You can improve LSP scaling by configuring the following RSVP-TE parameters:

- Refresh time
- Summary refresh time
- Bundle time

Refresh Time: The refresh time specifies the interval for sending refresh path messages. RSVP refresh messages provide soft state link-level keep-alive information for previously established paths and enable the switch to detect when an LSP is no longer active. RSVP sessions are torn down if an RSVP refresh message is not received from a neighbor within $[(keep-multiplier + 0.5) * 1.5 * refresh-time]$ seconds. The valid refresh time may be set to any value between 1 and 36000 seconds. The default setting is 30 seconds. Configuring a longer refresh time reduces both switch and network overhead.

Summary Refresh Time: The summary refresh time, specified in tenths of a second, indicates the time interval for sending summary refresh RSVP messages. The summary refresh time must be less than the configured refresh time. The default summary refresh time is zero, indicating that no summary refresh RSVP messages are sent. The summary refresh time value may be set to any value between zero to 100 (or 10 seconds). If configured, the bundled and summary refresh RSVP messages are only sent to RSVP-TE peers supporting RSVP refresh reduction.

Bundle Time: The bundle time, specified in tenths of a second, indicates the maximum amount of time a transmit buffer is held so that multiple RSVP messages can be bundled into a single PDU. The default

bundle time is zero, indicating that RSVP message bundling is not enabled. The bundle time value can be set to any value between zero and 30 (or 3 seconds).

Supporting Quality of Service Features

Quality of Service (QoS) LSP support is an important attribute of MPLS. MPLS supports the Differentiated Services (DiffServ) model of QoS. The DiffServ QoS model is supported by mapping different traffic classes to different LSPs, or by using the EXP bits in the MPLS shim header to identify traffic classes with particular forwarding requirements.

Propagation of IP TTL

There are two modes of operation for routed IP packets: pipe TTL mode and uniform TTL mode. Currently, switches that run Extreme OS support only the pipe TTL mode. In pipe TTL mode, the LSP is viewed as a point-to-point link between the ingress LSR and the egress LSR; intermediate LSRs in the MPLS network are not viewed as router hops from an IP TTL perspective. Thus, the IP TTL is decremented once by the ingress LSR, and once by the egress LSR.

In this mode, the MPLS TTL is independent of the IP TTL. The MPLS TTL is set to 255 on all packets originated by the switch and on all packets that enter a pseudo wire.

Configuring MPLS

MPLS has the following configuration constraints:

- **GARP VLAN Registration Protocol (GVRP)**—GVRP is not supported over MPLS LSPs.
- **Server Load Balancing (SLB)**—SLB and MPLS are mutually exclusive functions. Both functions cannot be simultaneously enabled.
- **IP flow redirection**—IP flow redirection commands and MPLS are mutually exclusive functions. Both functions cannot be enabled simultaneously.
- **IGMP snooping**—OSPF and LDP session establishment require the MSM/MM to receive and process IP multicast frames. Therefore, IGMP snooping must be enabled to support MPLS.
- **VPLS**—VPLS requires that IGMP snooping be disabled on customer-facing VLANs.

This section describes how to configure MPLS and includes the following topics:

- [Configuration Overview on page 1158](#)
- [Selecting the Enhanced Protocol on page 1158](#)
- [Moving MPLS From VR to VR on page 1159](#)
- [Configuring the MPLS LSR ID on page 1159](#)
- [Adding MPLS Support to VLANs on page 1159](#)
- [Enabling and Disabling MPLS on an LSR on page 1160](#)
- [Enabling and Disabling MPLS on a VLAN on page 1160](#)
- [Enabling LDP on the Switch on page 1160](#)
- [Enabling and Disabling LDP on a VLAN on page 1161](#)
- [Creating Static LSPs on page 1161](#)
- [Configuring Penultimate Hop Popping on page 1163](#)

- [Configuring QoS Mappings on page 1163](#)
- [Mapping Dot1p to EXP Bits on page 1164](#)
- [Enabling and Disabling LDP Loop Detection on page 1165](#)
- [Configuring an LDP Label Advertisement Filter on page 1165](#)
- [Configuring LDP Session Timers on page 1166](#)
- [Clearing LDP Protocol Counters on page 1167](#)
- [Resetting MPLS Configuration Parameter Values on page 1167](#)
- [Managing the MPLS BFD Client on page 1167](#)

Configuration Overview



NOTE

BlackDiamond 8800 series switches require specific software and hardware to support MPLS. For more information, see [Table 142 in Appendix A, “Feature License Requirements.”](#)

- 1 If MPLS will be used on a SummitStack or BlackDiamond 8800 series switch, select the enhanced protocol as described in [“Selecting the Enhanced Protocol” on page 1158](#).
- 2 If you want to use MPLS in a different VR (the default is *VR-Default*), move MPLS to the appropriate VR as described in [“Moving MPLS From VR to VR” on page 1159](#).
- 3 Create and configure the VLANs that will use MPLS.
- 4 Configure an MPLS LSR ID for each switch that serves as an LSR in the network. (See [“Configuring the MPLS LSR ID” on page 1159](#).)
- 5 Add MPLS support to the appropriate VLANs. (See [“Adding MPLS Support to VLANs” on page 1159](#).)
- 6 Enable MPLS on each switch that serves as an LSR. (See [“Enabling and Disabling MPLS on an LSR” on page 1160](#).)
- 7 Enable MPLS on the appropriate VLANs. (See [“Enabling and Disabling MPLS on a VLAN” on page 1160](#).)
- 8 Enable LDP on each switch that serves as an LSR. (See [“Enabling LDP on the Switch” on page 1160](#).)
- 9 Enable LDP on the appropriate VLANs. (See [“Enabling and Disabling LDP on a VLAN” on page 1161](#).)
- 10 Configure OSPF for the appropriate switches and VLANs.

Selecting the Enhanced Protocol

The enhanced protocol is required to support MPLS on the stacking links between Summit X460, X480, and X670 series switches, and on the switch fabric of BlackDiamond 8800 series switches.

On Summit X460, X480, and X670 series switches, the standard protocol previously used on these switches does not support MPLS. For information on selecting the enhanced stacking port protocol, see [“Selecting the Stacking Protocol” on page 171](#).

On BlackDiamond 8800 series switches, use the following command to select the enhanced protocol for the switch fabric:

```
configure forwarding switch-fabric protocol [standard | enhanced]
```

Moving MPLS From VR to VR

By default, MPLS is enabled on the *VR-Default* virtual router. You can operate MPLS in *VR-Default* or in any user VR, but MPLS only operates in one VR. If you want to use MPLS in a user VR, you must delete it from *VR-Default* first.

To delete MPLS from a VR, do the following:

- 1 Disable MPLS on the LSR as described in “[Enabling and Disabling MPLS on an LSR](#)” on page 1160.
- 2 Disable MPLS on all VLANs and reset the MPLS configuration as described in “[Resetting MPLS Configuration Parameter Values](#)” on page 1167.
- 3 Remove MPLS from the VR by entering the following command:

```
configure vr <vr-name> delete protocol <protocol-name>
```



NOTE

When you enter the command to delete MPLS from a VR, the software displays a prompt to remind you that the MPLS configuration is lost when MPLS is deleted.

To add MPLS to VR, do the following:

- 1 Enter the following command:

```
configure vr <name> add protocol <protocol-name>
```

- 2 Add any other protocols that you want to use with MPLS.

After you add MPLS to a VR, you must configure and enable MPLS. MPLS commands operate only in the VR to which MPLS is added. An error message appears if you enter an MPLS command in a VR that does not support MPLS.

Configuring the MPLS LSR ID

The MPLS LSR ID must be configured before MPLS can be used. The address chosen must be a routable IP address on the switch. It is suggested that this be set to the same IP address as a routing protocol ID (for example, the OSPF Router ID). To configure the MPLS LSR ID, use the following command:

```
configure mpls lsr-id <ipaddress>
```



NOTE

The MPLS LSR ID must be configured before MPLS can be enabled. The LSR ID should be configured on a loopback VLAN.

Adding MPLS Support to VLANs

To use MPLS on a VLAN, MPLS must first be configured on that VLAN. To configure a specific VLAN or all VLANs, use the following command:

```
configure mpls add {vlan} <vlan_name>
```

MPLS must be configured on a VLAN before it can be used to transmit or receive MPLS-encapsulated frames. By default, MPLS is not configured on a newly created VLAN.

If you have enabled MPLS on an OSPF interface that is used to reach a particular destination, make sure that you enable MPLS on all additional OSPF interfaces that can reach that same destination (for example, enable MPLS on all VLANs that are connected to the backbone network).

Enabling and Disabling MPLS on an LSR

To enable MPLS on an LSR, use the following command:

```
enable mpls
```



NOTE

Refer to the ExtremeXOS Command Reference description for the `enable mpls` command for special requirements for BlackDiamond 8800 series switches and SummitStack.

By default, MPLS is disabled on the switch. This command starts the MPLS process, allowing MPLS protocols to run and MPLS packets to be forwarded.

To disable MPLS on an LSR, enter the following command:

```
disable mpls
```

When you disable MPLS, LDP and RSVP-TE are effectively disabled. The MPLS configuration remains intact.

Enabling and Disabling MPLS on a VLAN

After MPLS is enabled globally, MPLS must be enabled on the MPLS configured VLANs. Configuring a VLAN for MPLS does not enable MPLS on the VLAN. The VLAN must be specifically MPLS enabled in order to send and receive MPLS packets over an interface.

To enable MPLS on specific VLANs, use the following command:

```
enable mpls [{vlan}<vlan_name>|vlan all]
```

To disable MPLS on specific VLANs, use the following command:

```
disable mpls [{vlan} <vlan_name> | vlan all]
```

MPLS must be enabled on all VLANs that transmit or receive MPLS-encapsulated frames. By default, MPLS and MPLS label distribution protocols are disabled when MPLS is first configured on a VLAN.

Enabling LDP on the Switch

To enable LDP on the switch, use the following command:

```
enable mpls protocol ldp
```

By default, LDP is disabled on the switch. This command enables MPLS to process LDP control packets and to advertise and receive LDP labels.

**NOTE**

Globally enabling the LDP protocol does not enable LDP on MPLS configured VLANs. See the next section for instructions on enabling LDP on a VLAN.

Enabling and Disabling LDP on a VLAN

Each VLAN must be specifically LDP-enabled in order to set up LDP adjacencies over the interface. Before LDP can be enabled on a VLAN, the VLAN must be configured to support MPLS as described in “Adding MPLS Support to VLANs” on page 1159.

To enable LDP on a VLAN, use the following command:

```
enable mpls ldp [{vlan} <vlan_name> | vlan all]
```

This command enables LDP on one or all VLANs for which MPLS has been configured.

**NOTE**

If you have enabled LDP and MPLS on an IGP interface that is used to reach a particular destination, make sure that you enable LDP and MPLS on all additional IGP interfaces that can reach that same destination (for example, enable LDP and MPLS on all OSPF VLANs that are connected to the backbone network).

To disable LDP on a VLAN, use the following command:

```
disable mpls ldp [{vlan} <vlan_name> | vlan all]
```

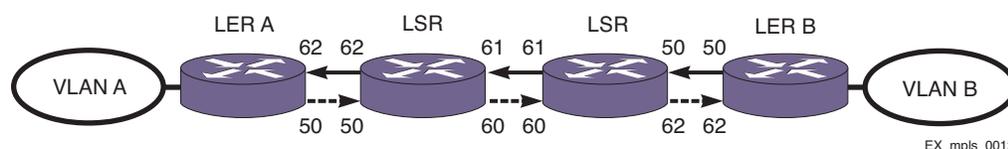
This command disables LDP on one or all VLANs for which MPLS has been configured. This command terminates all LDP hello adjacencies and all established LDP LSPs that use the specified interface(s).

Creating Static LSPs

Static LSPs are label switched paths that are manually configured at each LSR in the prospective path. Static LSPs are too labor intensive for building complex network topologies, but they can be useful for defining simple one-hop LSPs to MTUs that might not have the CPU power necessary to support routing and label distribution protocols.

Figure 187 shows two static LSPs configured between VLAN A and VLAN B. The dashed line shows the static LSP for unidirectional communications from VLAN A to VLAN B. The solid line shows the static LSP for communications in the reverse direction.

Figure 187: Static LSP Example



The path that an LSP takes and the labels the LSP uses at every hop do not change when the network topology changes due to links and nodes going up or down. Once enabled, a static LSP remains administratively up until it is manually disabled.

Static LSP configuration is different for ingress, transit, and egress LSRs. At the ingress LER, only an egress label is defined. At transit LSRs, both ingress and egress labels must be defined, and at the egress LER, only the ingress label is defined. During configuration, you must ensure that the egress label number for each LSR matches the ingress label number for the downstream LSR.

When creating static LSPs, consider the following guidelines:

- It is your responsibility to ensure that the egress label of an LSR matches the ingress label of the downstream LSR. The software does not detect or report label mismatches. Mismatches result in dropped or mis-routed packets.
- The operational state of the LSP is set to *down* at the head-end on local failures. However, there is no mechanism to detect the LSP going down when a failure occurs on a downstream node. When a failure occurs at a downstream node, traffic may be black-holed for the duration of the failure.
- The traffic profile for static LSPs is not configurable in this release. All static LSPs are given best effort treatment.
- The maximum number of static LSPs configurable on any given node is 1024. The maximum number of ingress static LSPs that are used to forward traffic to a single destination is 16 (as limited by ECMP).
- When multiple LSPs exist for the same destination, unless forced otherwise, signaled LSPs are preferred to static LSPs. When choosing an LSP for a FEC, the software prefers RSVP-TE LSPs first, LDP next, and finally static LSPs.
- Since the software has no knowledge of the cost or hop-count associated with each static LSP, all static LSPs to the same destination are equally preferred by IP routing.
- Extreme Networks recommends that the same LSP name be used on every LSR along the path of the static LSP. The software does not check for naming consistency across LSRs. However the switch does report an error when the configured name is not unique to the LSP on that LSR.

To configure a static LSP, use the following procedure at each node on the path:

- 1 Create a namespace for the LSP using the following command:

```
create mpls static lsp <lsp_name> destination <ipaddress>
```

- 2 Configure the appropriate labels for the LSP using the following command:

```
configure mpls static lsp <lsp_name> [{egress [<egress-label> | implicit-null]
egress-vlan <evlan_name> next-hop <ipaddress>} {ingress <ingress-label> {ingress-
vlan <ivlan_name>}}]
```

- 3 Configure optional traffic restrictions for IP or VPN traffic as needed using the following command:

```
configure mpls static lsp <lsp_name> transport [ip-traffic [allow | deny] | vpn-
traffic [allow {all | assigned-only} | deny]]
```

- 4 Enable the static LSP for operation using the following command:

```
enable mpls static lsp {<lsp_name> | all }
```

When the configuration is complete, you can view the static LSP configuration with the following command:

```
show mpls static lsp {summary | {<lsp_name>} {detail}}
```

To clear the counters for the static LSP, enter the following command:

```
clear counters mpls static lsp {<lsp_name> | all }
```

Once the static LSP is created on all path nodes, you can configure a default route, an IP route, or a VPN route to use the LSP. To configure a default or IP route to use the LSP, enter the following command:

```
configure iproute add default [{<gateway> <metric>} {vr <vrname>} {unicast-only |
multicast-only}] | {lsp <lsp_name> <metric>}}
```

To configure a VPN route to use the LSP, enter the following command:

```
configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] peer <ipaddress> [add | delete]
mpls lsp <lsp_name>
```

To disable a static LSP, enter the following command:

```
disable mpls static lsp [<lsp_name> | all ]
```

To delete a static LSP, enter the following command:

```
delete mpls static lsp [<lsp_name> | all]
```

Configuring Penultimate Hop Popping

To enable or disable PHP, use the following command:

```
enable mpls php [{vlan} <vlan_name> | vlan all]
```

This command enables or disables whether PHP is requested by the egress LER. If `vlan all` is selected, PHP is enabled on all VLANs on which MPLS has been configured. By default, PHP is disabled.

When PHP is enabled, PHP is requested on all LSPs for which the switch is the egress LER.

PHP is requested by assigning the Implicit Null Label in an advertised mapping. PHP is always performed when requested by a peer (for example, when acting as an intermediate LSR).

Configuring QoS Mappings

The ExtremeXOS software provides examination and replacement services for the EXP field. These services behave like the dot1p QoS commands. When EXP examination is enabled, the EXP value from the received frame is used to assign the packet to a QoS profile. Once a packet is assigned to a QoS profile, the EXP value may be overwritten in hardware before being transmitted. By default, the QoS profile EXP value is equivalent to the QoS profile number one (QP1). To enable QoS for MPLS LSPs, use the following command:

```
enable mpls exp examination
```

This command enables EXP examination for MPLS received packets. When EXP examination is enabled, the EXP field in the outer or top label of the label stack is used to assign the received packet to an internal switch qosprofile. If enabled, all MPLS packets are mapped to a qosprofile based on the configured EXP bit value. That is, a packet with an EXP value of 0 is mapped to qosprofile QP1, a packet with an EXP value of 1 is mapped to qosprofile QP2, and so on. By default, EXP examination is disabled and all received MPLS packets are sent to QP1.

Each EXP value can be assigned a qosprofile. Multiple EXP values can be assigned to the same qosprofile. The following command is used to configure the switch to route packets with a received EXP value to a specific qosprofile:

```
configure mpls exp examination {value} <value> {qosprofile} <qosprofile>
```

The switch can overwrite the EXP value in the outer label of an MPLS packet. The following command is used to enable the switch to replace the EXP value:

```
enable mpls exp replacement
```

This command enables EXP replacement for MPLS transmitted packets. When EXP replacement is enabled, the EXP field in the outer or top label of the label stack is replaced with the EXP value configured for the QoS profile for which the packet was assigned. By default, EXP replacement is disabled and packets are propagated without modifying the EXP field value.

Each qosprofile can be assigned an EXP value used to overwrite the EXP bit field in the outer label of the transmitted packet. All qosprofiles can be configured to overwrite the EXP bit field using the same EXP value. The following command is used to configure the switch to overwrite MPLS packets transmitted from a specific qosprofile with a new EXP value:

```
configure mpls exp replacement {qosprofile} <qosprofile> {value} <value>
```



NOTE

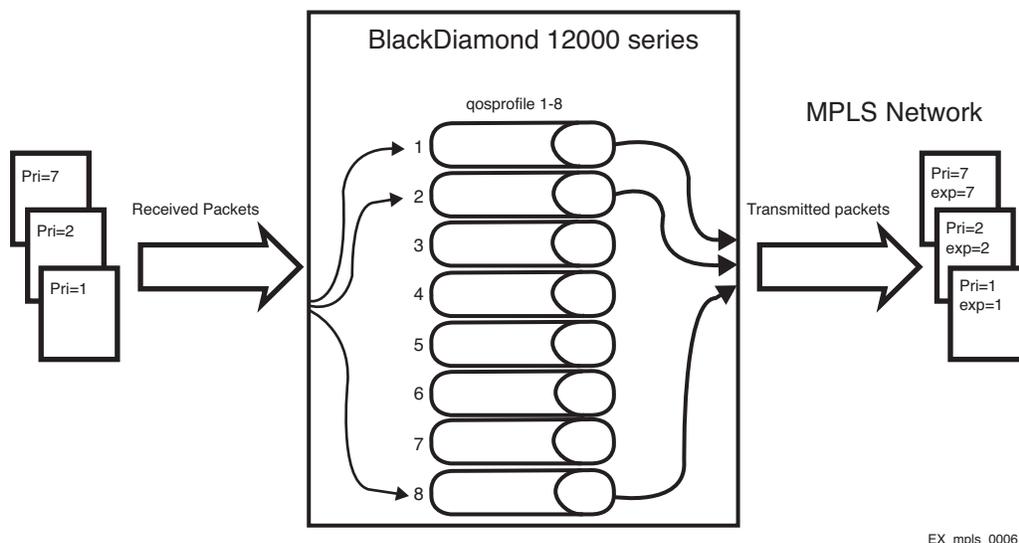
On the X480, X460, E4G200, E4G400, X670, and BlackDiamond X8, when exp examination is enabled, the dot1p value of VPLS/VPWS terminated frames are set from the internal priority. The enable/disable dot1p replacement commands do not have any effect in this situation. A future release will eliminate this restriction.

Mapping Dot1p to EXP Bits

The priority of Ethernet tagged packets can be mapped into the MPLS network and vice versa using the switch fabric qosprofile. Ethernet packets are assigned to a qosprofile by enabling dot1p examination. MPLS packets are assigned to a qosprofile by enabling exp examination. When the packets egress the switch, the dot1p and exp bit fields can be overwritten.

Enabling exp replacement instructs the switch to overwrite both the dot1p field and the exp field in the outer most label.

Figure 188: Mapping Dot1p to EXP Bits



By default, when dot1p examination and exp replacement are not enabled, all received packets are routed through qosprofile qp1 and the packets are transmitted with the dot1p and exp value of zero. As

shown in the figure above, the switch can be configured to route packets to a specific qosprofile based on the dot1p value in the 802.1p bit field. In this example dot1p examination is enabled. By default, when dot1p examination is enabled, packets are sent to the qosprofile that corresponds to the dot1p value. A dot1p value of 0 maps to qosprofile 1, a dot1p value of 1 maps to qosprofile 2, and so on. By default, MPLS exp replacement is disabled. By enabling MPLS exp replacement, MPLS packets are transmitted with the configured qosprofile dot1p and exp value. By default, these values correspond to the qosprofile. Qosprofile 1 overwrites the dot1p and exp fields with 0, qosprofile 2 overwrites the dot1p and exp fields with 1, and so on.

To configure the reverse packet flow, mpls exp examination and dot1p replacement must be configured. Enabling MPLS exp examination instructs the switch to route received MPLS packets to a qosprofile based on the EXP value. Enabling dot1p replacement instructs the switch to write the dot1p value in the transmitted packet.

Enabling and Disabling LDP Loop Detection

There are two types of LDP loop detection. By default both are disabled. Enabling loop detection allows the switch to detect if a label advertisement loop exists within the network. Both hop count and path vector loop detection methods are used if loop detection is enabled. To enable LDP loop detection, use the following command:

```
enable mpls ldp loop-detection
```

To disable LDP loop detection, use the following command:

```
disable mpls ldp loop-detection
```

These commands affect the LDP loop detection behavior for all LDP enabled VLANs.

Configuring an LDP Label Advertisement Filter

To configure an LDP label advertisement filter, use the following command:

```
configure mpls ldp advertise [{direct [all | lsr-id | none]} | {rip [all | none] |
{static [all | none]}]
```

This command configures a filter to be used by LDP when originating unsolicited label mapping advertisements to LDP neighbors.

You can configure how the advertisement filter is applied, as follows:

- `direct`—The advertisement filter is applied to the FECs associated with direct routes.
- `rip`—The advertisement filter is applied to the FECs associated with RIP routes.
- `static`—The advertisement filter is applied to the FECs associated with static routes.

You can configure the advertisement filter, as follows:

- `all`—Unsolicited label mappings are originated for all routes of the specified type (direct, RIP, or static).
- `lsr-id`—An unsolicited label mapping is originated if a /32 direct route exists that matches the MPLS LSR ID. This filter is the default setting for direct routes and is only available for direct routes.
- `none`—No unsolicited label mappings are originated for all routes of the specified type. This is the default setting for RIP and static routes.

You can control the number of labels advertised using the `configure mpls ldp advertise` command. Advertising labels for a large number of routes can increase the required number of labels that must be allocated by LSRs. Care should be used to insure that the number of labels advertised by LERs does not overwhelm the label capacity of the LSRs.

Configuring LDP Session Timers

To configure LDP session timers, use the following command:

```
configure mpls ldp timers [targeted | link] [{hello-time <hello_hold_seconds>} {keep-
alive-time <keep_alive_hold_seconds>}]
```

This command configures the LDP peer session timers for the switch. The LDP peer session timers are separately configurable for `link` and `targeted` LDP hello adjacencies.

The `hello-time <hello_hold_seconds>` parameter specifies the amount of time (in seconds) that a *hello* message received from a neighboring LSR remains valid. The rate at which *hello* messages are sent is one third the configured `hello-time`. If a *hello* message is not received from a particular neighboring LSR within the specified `hello-time <hello_hold_seconds>` then the hello-adjacency is not maintained with that neighboring LSR. Should two peers have different configured *hello-time* values, they negotiate to use the lower value.

The session `keep-alive time <keep_alive_hold_seconds>` parameter specifies the time (in seconds) during which an LDP message must be received for the LDP session to be maintained. The rate at which *keep alive* messages are sent, provided there are no LDP messages transmitted, is one sixth the configured `keep-alive-time`. If an LDP PDU is not received within the specified session `keep-alive time <keep_alive_hold_seconds>` interval, the corresponding LDP session is torn down. Should two peers have different configured *keep-alive-time* values, they negotiate to use the lower value.

In the event that two peers have both a link and a targeted hello adjacency, the *hello-time* values for the two hello adjacencies are negotiated separately. The *keep-alive-time* value is established based on negotiations occurring when the LDP session is established following the first hello adjacency to be established.

The minimum and maximum values for both the `hello-time <hello_hold_seconds>` and `keep-alive time <keep_alive_hold_seconds>` are 6 and 65,534, respectively. Changes to targeted timers only affect newly created targeted peers. Disabling and then enabling all VPLS instances causes all current targeted peers to be re-created.

The default values are as follows:

- `link ldp hello-time <hello_hold_seconds>` – 15
- `targeted-ldp hello-time <hello_hold_seconds>` – 45
- `link ldp hello-time <interval_time>` – auto set to 1/3 the configured hello-time
- `targeted-ldp hello-time <interval_time>` – auto set to 1/3 the configured hello-time
- `link ldp keep-alive <keep-alive hold-seconds>` – 40
- `targeted-ldp keep-alive <keep-alive hold-seconds>` – 60
- `link ldp keep-alive <interval_time>` – auto set to 1/6 the configured keep-alive time
- `targeted-ldp keep-alive <interval_time>` – auto set to 1/6 the configured keep-alive time

Restoring LDP Session Timers

To restore the default values for LDP session timers, use the following command:

```
unconfigure mpls
```

This command can only be executed when MPLS is disabled, and it restores all MPLS configuration settings.

Clearing LDP Protocol Counters

To clear the LDP control protocol error counters, use the following command:

```
clear counters mpls ldp {{{vlan} <vlan_name>} | lsp all}
```

Omitting the optional vlan parameter clears counters for all LDP enabled interfaces.

Resetting MPLS Configuration Parameter Values

To reset MPLS configuration parameters to their default values, disable MPLS (see [“Enabling and Disabling MPLS on an LSR” on page 1160](#)) and then enter the following command:

```
unconfigure mpls
```

This command affects the following configuration parameters:

- All VLANs are removed from MPLS.
- All EXP (examination and replacement) QOS mappings are reset.
- LSR-ID is reset.
- LDP and RSVP-TE are globally disabled.
- MPLS Traps are disabled.
- LDP and RSVP-TE timers are reset.
- LDP Advertisement settings are reset.
- LDP Loop Detection settings are reset.
- All RSVP-TE LSPs are deleted.
- All RSVP-TE Paths are deleted.
- All RSVP-TE Profiles are deleted.
- The default RSVP-TE Profile is reset.

Managing the MPLS BFD Client

Bidirectional Forwarding Detection (BFD) is introduced in [“Bidirectional Forwarding Detection \(BFD\)” on page 432](#). The MPLS BFD client enables rapid detection of failures between MPLS neighbors on specific VLANs. BFD detects forwarding path failures at a uniform rate, which makes the re-convergence time consistent and predictable and makes network profiling and planning easier for network administrators.

When BFD detects a communication failure, it informs MPLS, which treats the indication as an interface (VLAN) failure. This allows the MPLS protocols to quickly begin using alternate paths to affected neighbors (the methodology for selecting alternate paths is dependent upon the MPLS protocol in use and how it reacts to interface failure conditions). As MPLS connections (LSPs) are removed from the

interface, BFD sessions are removed as well, and the interface returns to a state without BFD protection. The MPLS protocol might continue to attempt to reestablish LSP connections across the interface, and if successful, also attempt to establish a BFD session with the corresponding neighbor. MPLS does not process BFD state changes until the BFD session is fully active in the *UP* state, at which point state changes are processed and the state for LSPs which cross the interface becomes *BFD protected*.

**NOTE**

BFD sessions are established only when both peers select the same LSP route. Extreme Networks recommends that BFD operate only on interfaces that have one peer.

To enable the MPLS BFD client, use the following command:

```
enable mpls bfd [{vlan} <vlan_name> | vlan all]
```

**NOTE**

BFD must be enabled on the interface before sessions can be established. To enable BFD, use the command: `[enable | disable] bfd vlan <vlan_name>`.

To disable the MPLS BFD client, use the following command:

```
disable mpls bfd [vlan all | {vlan} <vlan_name>] {delete-sessions}
```

To display the MPLS BFD client information, use the following commands:

```
show mpls interface [{vlan} <vlan_name>] {detail}
show mpls bfd [{vlan} <vlan_name> | ip_addr]
```

Displaying MPLS Configuration Information

The following sections explain how to display MPLS configuration information:

- [Displaying MPLS Basic Configuration Information on page 1169](#)
- [Displaying LDP Basic Configuration Information on page 1169](#)
- [Displaying MPLS Interface Information on page 1170](#)
- [Displaying LDP Interface Information on page 1170](#)
- [Displaying MPLS Label Information on page 1171](#)
- [Displaying MPLS Label Mapping Information on page 1171](#)
- [Displaying MPLS QoS Mapping Information on page 1172](#)
- [Displaying LDP Peer Session Information on page 1172](#)
- [Displaying LDP Protocol Counters on page 1173](#)
- [Displaying LDP LSP Forwarding Database on page 1173](#)
- [Displaying RSVP-TE LSP Configuration Information on page 1174](#)
- [Displaying the RSVP-TE Paths on page 1175](#)
- [Displaying the RSVP-TE Path Profile on page 1175](#)
- [Displaying the RSVP-TE LSP on page 1175](#)

Displaying MPLS Basic Configuration Information

To display basic MPLS configuration information, use the following command:

```
show mpls
```

This command displays the general configuration of all the MPLS components and system wide configuration. The output, shown below, displays the switch MPLS, RSVP-TE, and LDP configuration status. It also shows the configuration status of SNMP trap, EXP examination, and EXP replacement settings. The configured LSR ID and all configured MPLS VLANs are also shown.

```
* BD-10K.4 # show mpls

Virtual Router Name           : VR-Default
MPLS Admin Status            : Enabled
MPLS Oper Status              : Enabled
RSVP-TE Admin Status         : Enabled
RSVP-TE Oper Status          : Enabled
LDP Admin Status              : Enabled
LDP Oper Status               : Enabled
MPLS SNMP Traps               : Disabled
L2VPN SNMP Traps             : Disabled
EXP Examination                : Enabled
EXP Replacement               : Disabled
LSR ID                        : 192.99.1.5
```

Displaying LDP Basic Configuration Information

To display basic LDP configuration information, use the following command:

```
show mpls ldp
```

This command displays the general configuration of LDP. Some settings are not configurable. These fields are identified with an asterisk (*). The remaining fields can be modified using LDP configuration commands to change the behavior of LDP. A list of VLANs that have LDP enabled is shown at the bottom of the display output.

```
* BD-10k.6 # show mpls ldp

LDP Status                    : Enabled
Protocol Version               : v1*
Label Retention Mode           : Liberal*
Label Distribution Method      : Downstream Unsolicited*

LDP Loop Detection
  Status                       : Disabled
  Hop-Count Limit              : 255
  Path-Vector Limit            : 255

LDP Targeted Timers
  Hello Hold                   : 45 seconds
  Keep Alive Hold              : 60 seconds

LDP Link Timers
  Hello Hold                   : 15 seconds
  Keep Alive Hold              : 40 seconds

Label Advertisement
```

```

Direct : All
Rip    : None
Static : None

```

```

LDP VLANs : loopback
           : blowingrock
           : boone
           : asheville

```

* Indicates parameters that cannot be modified

Displaying MPLS Interface Information

To display the MPLS interface information, use the following command:

```
show mpls interface {{vlan} <vlan_name>} {detail}
```

When the optional parameters are omitted, this command displays information for all the configured MPLS VLAN interfaces. The summary MPLS interface information displayed includes the configured IP address, approximate time RSVP-TE and LDP have been up, number of neighbors or adjacencies, and a set of status flags.

When the `vlan_name` parameter is specified, this command displays the current MPLS interface summary configuration and status for only the specified VLAN. If the optional `detail` keyword is specified, the summary information is displayed in the detail format.

Displaying LDP Interface Information

To display LDP interface information, use the following command:

```
show mpls ldp interface {{vlan} <vlan_name>} {detail | counters}
```

This command displays the operational LDP interface information. All the VLANs that have LDP enabled are listed. The negotiated LDP hello hold time is displayed. This is not the configured LDP hello hold time but represents the value that is negotiated between the local switch and the connected LDP peer. Hello messages are transmitted every 1/3 the negotiated hello hold time. In the following example, that would be every 5 seconds. The hello timer status information is displayed in milliseconds. The approximate LDP uptime and status flags are also shown.

```
* BD-10K.7 # show mpls ldp interface
VLAN Name      #Adj  NegHHldTm  NxtHello  UpTm  Flags
-----
loopback       0      15000      2230      16h  MLU
blowingrock    1      15000      2200      14h  MLU
boone          1      15000      2210      16h  MLU
asheville     1      15000      2210      16h  MLU
```

```
Flags: (M) MPLS Enabled, (L) LDP Enabled,
       (U) LDP Operational
```

Displaying MPLS Label Information

To display MPLS label information, use the following commands:

```
show mpls {rsvp-te | static} label {summary | <label_num> | [advertised | received]
<label_num>} | received implicit-null}
```

```
show mpls {ldp} label {lsp} {summary | <label_num> | [advertised | received]
<label_num>} | received implicit-null}
```

```
show mpls ldp label {lsp} advertised implicit-null {<ipNetmask>}
```

```
show mpls {ldp} label l2vpn {summary | <label_num> | [advertised | received]
<label_num>}}
```

```
show mpls ldp label l2vpn retained {<ipaddress>}
```

```
show mpls ldp label lsp retained {<ipNetmask>}
```

```
show mpls ldp label retained [l2vpn {<ipaddress>} | lsp {<ipNetmask>}]
```

Displaying MPLS Label Mapping Information

To display MPLS label mapping information, use the following commands:

```
show mpls ldp lsp {prefix <ipNetmask>} {ingress | egress | transit} {detail}
```

```
show mpls rsvp-te lsp [egress | transit] {fast-reroute} {{<lsp_name>} {[destination |
origin] <ipaddress>} {detail} | summary}
```

This command displays information about how to forward packets that arrive labeled as MPLS packets. As such, it shows how labels advertised to upstream peers are mapped to labels received from downstream peers. This mapping is sometimes referred to as the Incoming Label Map (ILM).

When the `label_number` parameter is omitted, summary information is displayed for all incoming label assignments that have been made by the switch. When the `label_number` is specified, summary information is displayed for the specified label.

As can be seen below, the output display differs for label mappings signaled by LDP and RSVP-TE. Please see the respective sections for additional information.

```
* BD-10K.5 # show mpls ldp lsp
Prefix          Adv Label Peer Label Next Hop          VLAN
192.168.0.4/32  0x80402    --      --      --      lpbk
192.168.0.2/32  0x00039   0x80400  11.0.2.2  vlan2
11.0.4.0/24    0x0003A   0x80401  11.0.2.2  vlan2
192.168.0.4/32  0x0003B   0x00013  11.0.2.2  vlan2

* BD-10K.6 # show mpls rsvp-te lsp
Ingress LSP Name Path Name          Destination          Transmit I/F          UpTm
Flags
-----
-----
-----
LSR1-LSR4      path1-2-4          192.168.0.4          vlan2                 47m
UEP--OIV
```

Egress LSP Name	Source IP	Destination	Receive I/F	UpTm
LSR4-LSR1	192.168.0.4	192.168.0.1	vlan1	47m

Transit LSP Name	Source IP	Destination	Receive I/F	Transmit I/F	UpTm
LSR2-LSR3	192.168.0.2	192.168.0.3	vlan2	vlan1	47m

Flags: (U) Up, (E) Enabled, (P) Primary LSP, (S) Secondary LSP,
 (R) Redundant Paths, (B) Bandwidth Requested, (O) ERO Specified,
 (I) IP Traffic Allowed, (V) VPN Traffic Allowed,
 (v) VPN Assigned Traffic Allowed

Displaying MPLS QoS Mapping Information

To display MPLS QoS mapping information, use the following command:

```
* BD-10K.10 # show mpls exp examination
EXP --> QoS Profile mapping:
    00 --> QP1
    01 --> QP2
    02 --> QP3
    03 --> QP4
    04 --> QP5
    05 --> QP6
    06 --> QP7
    07 --> QP8
EXP Examination is disabled
* BD-10K.11 # show mpls exp replacement
QoS Profile --> EXP mapping:
    QP1 --> 00
    QP2 --> 01
    QP3 --> 02
    QP4 --> 03
    QP5 --> 04
    QP6 --> 05
    QP7 --> 06
    QP8 --> 07
EXP Replacement is disabled
* BD-10K.12 #
```

Configured mappings for both dot1p-to-exp and exp-to-dot1p are displayed.

Displaying LDP Peer Session Information

To display MPLS LDP peer session information, use the following command:

```
show mpls ldp peer {<ipaddress>} {detail}
```

This command displays information about the status of LDP peer sessions. Summary information is displayed for all known LDP peers and LDP peer sessions. If you specify the <ipaddress> of an LDP peer, information for the single LDP peer is displayed. If you specify the `detail` keyword, additional information is displayed in a comprehensive detailed format.

By default the information displayed includes:

- Peer sessions
- Peer state
- Uptime
- Number of hello adjacencies

If you specify the `detail` keyword, the following additional information is displayed:

- Discontinuity time
- Negotiated label distribution
- Next hop address
- Keep-Alive hold timer
- Hello adjacency details

Displaying LDP Protocol Counters

LDP control protocol packet error counters are maintained per interface. To view these counters, use the following command:

```
show mpls ldp interface {{vlan} <vlan_name>} {detail | counters}
```

These counters may be useful in determining LDP issues between peers. Error counters that continually increment should be investigated.

```
* BD-10K.20 # show mpls ldp interface vlan blowingrock counters
```

```
VLAN: blowingrock (192.60.40.5)
Link      Targeted
Counter
-----
Shutdown Notifications (Rcvd)          0          0
Shutdown Notifications (Sent)         0          0
Failed Session Attempts (NAKs)        0          0
Hello Errors                           0          0
Parameters Advertised Errors          0          0
Max PDU Length Errors                 0          0
Label Range Errors                    0          0
Bad LDP ID Errors                     0          0
Bad PDU Length Errors                 0          0
Bad Msg Length Errors                 0          0
Bad TLV Length Errors                 0          0
Bad TLV Value Errors                  0          0
Keep-Alive Timeout Errors              0          0
```

Omitting the optional `vlan` parameter displays counters for all LDP enabled interfaces.

Displaying LDP LSP Forwarding Database

To display information about LDP LSPs, use the following command:

```
show mpls ldp lsp {prefix <ipNetmask>} {egress | ingress | transit} {detail}
```

This command displays the LDP LSPs established to, from, and through this switch. By default, ingress, egress, and transit LSPs are all displayed. By optionally specifying the LSP type, the output display is filtered to show only the type of LSPs specified.

When all LSP types are being displayed, LSPs that show only an advertised label represent egress LSPs from the network perspective or incoming LSPs from the switch perspective. LSPs that show only a received label represent ingress LSPs from the network perspective or outgoing LSPs from the switch perspective. LSPs that show both an incoming and an outgoing label represent transit LSPs. As Extreme switches are merge-capable, all LDP transit LSPs can also be used as ingress LSPs.

The significance of the VLAN information shown depends on the LSP type. For ingress and transit LSPs, the indicated VLAN is the MPLS interface used to reach the next hop peer. For egress LSPs, there is no associated MPLS next hop interface. When the prefix being advertised is associated with a local (direct) VLAN, that VLAN name is displayed. When the advertised prefix is associated with a static or an RIP route, the VLAN field is empty.

Advertised labels have switch-wide significance and are generally advertised out multiple interfaces.

```
* BD-10K.15 # show mpls ldp lsp
  Prefix          Adv Label Peer Label Next Hop      VLAN
192.99.1.5/32    0x80402  --      --      loopback
192.80.40.0/24  0x80403  --      --      asheville
192.100.40.0/24 0x80404  --      --      boone
192.60.40.0/24  0x8040b  --      --      blowingrock
192.24.100.0/24 0x00015  0x80401  192.100.40.3 boone
192.99.1.3/32   0x00016  0x80403  192.100.40.3 boone
192.10.50.0/24  0x00018  0x80405  192.100.40.3 boone
10.20.30.0/24   0x0001c  0x00013  192.100.40.3 boone
11.136.96.0/24  0x0001d  0x00014  192.100.40.3 boone
```

Specifying the optional detail keyword displays each LSP in detail format. Additionally, received packets and bytes are maintained for transit and egress (or incoming) LSPs. Specifying the keyword prefix and a matching ipNetmask restricts the display to a single entry.

```
*BD-X8.17 # show mpls ldp lsp prefix 11.108.96.0/24 detail
FEC IP/Prefix: 11.108.96.0/24:
  Advertised Label: 0 (0)
  Received Label   : 0x18 (24)
  Next Hop IP      : 192.100.40.3
  VLAN Name        : boone
  Packets received :          489
  Bytes received   :        46944
```

Displaying RSVP-TE LSP Configuration Information

To display RSVP-TE LSP configuration information, use the following command:

```
show mpls rsvp-te
```

This command displays summary configuration and status information for RSVP-TE. Global status of RSVP-TE and the configured standard and rapid-retry LSP timer values are included in the display output.

Displaying the RSVP-TE Paths

To display RSVP-TE paths, use the following command:

```
show mpls rsvp-te path {<path_name>} {detail}
```

This command displays the configuration and status information for MPLS RSVP-TE paths. Information is listed in tabular format and includes the path name, number of configured ERO objects, number of LSPs configured to use this path, the list of EROs and their type. Optionally specifying the `detail` keyword displays the path information in verbose format, including all LSPs that are configured to use the path.

Displaying the RSVP-TE Path Profile

To display RSVP-TE path profiles, use the following command:

```
show mpls rsvp-te profile {<profile_name>} {detail}
```

By default, this command displays all configured profile parameters for the specified profile. If the profile name is omitted, the profile parameter values for all configured LSP profiles are displayed. Optionally specifying the keyword `detail` displays the profile information in verbose format. When the `detail` keyword is specified, all LSPs that are configured to use this profile are also displayed.

Displaying the RSVP-TE LSP

To display the RSVP-TE LSP, use the following command:

```
show mpls rsvp-te lsp {[[destination | origin] <ipaddress>} {fast-reroute} {detail} | summary}
```

This command displays the LSP information associated with RSVP-TE that is used to forward packets within the MPLS network. If no options are specified, summary information for all RSVP-TE LSPs is displayed. This information includes the LSP name, LSP direction relative to the MPLS network (i.e., ingress, egress, or transit), incoming and/or outgoing interface, configured destination, and uptime. If the optional LSP name parameter is specified, only the LSP information for the specified ingress LSP name is displayed. Optionally, the LSPs displayed can be further qualified by the keywords `ingress`, `egress`, and `transit`. These keywords qualify the LSPs displayed from the perspective of the switch.

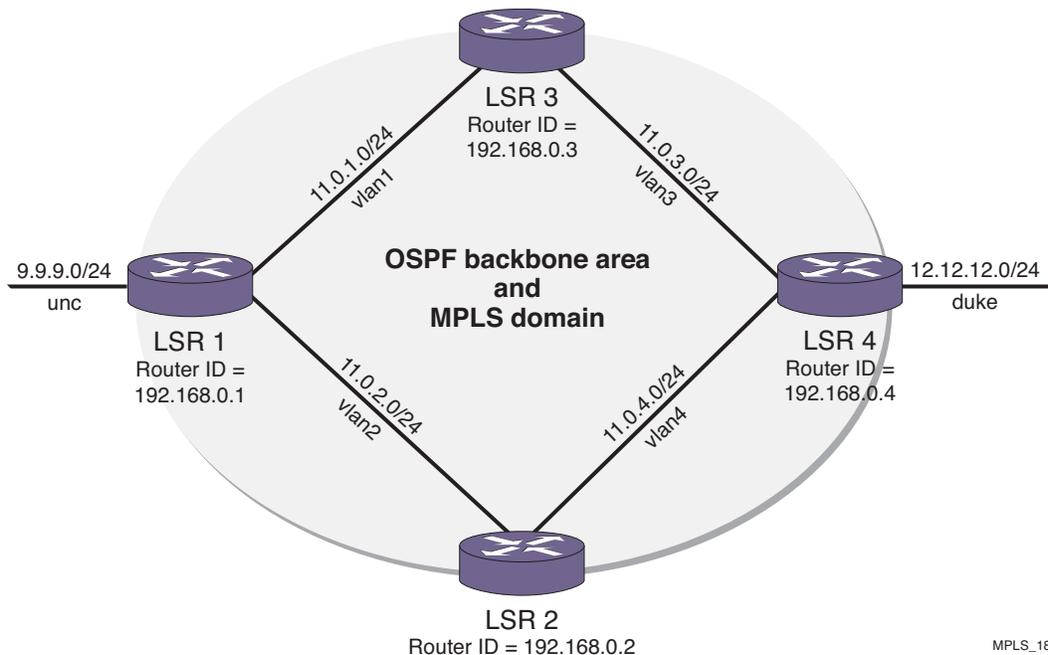
Ingress LSPs identify LSPs that originate from the switch into the MPLS network. Egress LSPs identify LSPs that terminate at the switch from the MPLS network. Transit LSPs represent LSPs that traverse the switch.

The optional `destination` keyword limits the display to only those LSPs that terminate at the specified IP address. The optional `origin` keyword limits the display to only those LSPs that originate at the specified IP address. Optionally specifying the `detail` keyword displays the LSP information in verbose format. Additional information displayed includes the configured path and profile, transmit and/or receive labels, failure and retry counts, packet and byte counters, and recorded routes.

MPLS Configuration Example

The network configuration, shown in [Figure 189](#), illustrates how to configure a BlackDiamond switch to support a routed MPLS network.

Figure 189: MPLS Configuration Example



The four switches, labeled LSR 1, LSR 2, LSR 3, and LSR 4, have the same physical hardware configuration. Each switch contains a GM-20XT, XM-2X and an MSM-5 module. The switches are all interconnected via Gigabit Ethernet to form the OSPF backbone area and the MPLS domain. In this example, two directly connected OSPF-disabled VLANs are shown: *unc* and *duke*. Traffic between *unc* and *duke* follows routed paths over calculated LSPs established between LSR 1 and LSR 4.

The commands used to configure LSR 1 are described below. The remaining LSRs are configured similarly.

The following commands configure the module types for specific slots:

```
configure slot 2 module xm-2x
configure slot 3 module gm-20xt
```

The following command sets the maximum jumbo frame size for the switch chassis to 1600:

```
configure jumbo-frame-size size 1600
enable jumbo-frame ports all
```

The following commands create the VLANs:

```
create vlan lpbk
create vlan vlan1
create vlan vlan2
create vlan unc
```

The following commands configure the VLAN IP address and assign ports participating in each VLAN:

```
configure vlan lpbk ipaddress 192.168.0.1/32
enable ipforwarding lpbk
enable loopback-mode lpbk
configure vlan default delete ports all
configure vlan vlan1 ipaddress 11.0.1.1/24
configure vlan vlan1 add port 3:2 untagged
configure vlan vlan2 ipaddress 11.0.2.1/24
```

```
configure vlan vlan2 add port 3:3 untagged
configure vlan unc ipaddress 9.9.9.1/24
configure vlan unc add port 3:4 untagged
```

The following commands enable IP forwarding on the configured VLANs. The MTU size is increased on the MPLS VLANs to accommodate the MPLS shim header:

```
enable ipforwarding vlan vlan1
configure ip-mtu 1550 vlan vlan1
enable ipforwarding vlan vlan2
configure ip-mtu 1550 vlan vlan2
enable ipforwarding vlan unc
```

The following command configures the MPLS LSR ID:

```
configure mpls lsr-id 192.168.0.1
```

The following commands add MPLS support to VLANs *lpbk*, *vlan1*, and *vlan2*:

```
configure mpls add vlan lpbk
configure mpls add vlan vlan1
configure mpls add vlan vlan2
```

The following commands enable MPLS on VLANs *lpbk*, *vlan1*, and *vlan2* and LDP on VLANs *vlan1* and *vlan2*:

```
enable mpls lpbk
enable mpls vlan1
enable mpls vlan2
enable mpls ldp vlan1
enable mpls ldp vlan2
```

The following command allows LDP to advertise a label mapping for the LSR ID:

```
configure mpls ldp advertise direct lsr-id
```

The following commands globally enable LDP and MPLS on the switch:

```
enable mpls protocol ldp
enable mpls
```

The following commands add *lpbk*, *vlan1*, and *vlan2* to the backbone area. The 0.0.0.0 (backbone) area does not need to be created because it exists by default:

```
configure ospf add vlan lpbk area 0.0.0.0
configure ospf add vlan vlan2 area 0.0.0.0
configure ospf add vlan vlan1 area 0.0.0.0
```

The following command enables distribution of local (direct) interfaces into the OSPF area:

```
enable ospf export direct cost 10 type ase-type-1
```

The following command configures the OSPF router ID on the switch and enables the distribution of a route for the OSPF router ID in the router LSA. Originating the router ID as a host route allows other routers in the same OSPF area to establish calculated LSPs for external routes to this router:

```
configure ospf routerid 11.0.1.11
```

It also allows this router to be a peer in a L2 VPN.

The following command enables OSPF:

```
enable ospf
```

Configuring MPLS Layer-2 VPNs (VPLS and VPWS)

This section describes how to configure MPLS Layer-2 VPNs, and includes the following topics:

- [Configuring MPLS for Establishing Layer 2 VPN Instances on page 1178](#)
- [Creating or Deleting a Layer 2 VPN Domain on page 1178](#)
- [Enabling or Disabling a Layer 2 VPN Domain on page 1179](#)
- [Adding or Deleting a Layer 2 VPN Peer on page 1179](#)
- [Adding or Deleting a Layer 2 VPN Service on page 1180](#)
- [Enabling or Disabling a Layer 2 VPN Service on page 1180](#)
- [Managing Layer 2 VPN Packet Forwarding Options on page 1180](#)
- [Configuring the Layer 2 VPN MTU on page 1181](#)
- [The Layer 2 VPN MTU value is signaled to peers as part of the VC FEC information during PW setup. The local value must match the value received from the PW peer. If the two values do not match, the PW is not established. on page 1181](#)
- [Managing VPLS Redundancy Options on page 1181](#)
- [Displaying Layer 2 VPN Status on page 1182](#)
- [Displaying Layer 2 VPN Statistics on page 1182](#)
- [Managing Layer 2 VPN SNMP Traps on page 1182](#)



NOTE

ELRP should not be used to protect VPLS service VLANs because ELRP is not aware of VPLS pseudo wires.

Configuring MPLS for Establishing Layer 2 VPN Instances

As described in [“Using LDP to Signal PW Label Mappings” on page 1126](#), MPLS and LDP must be properly configured in order to establish the PWs that make up a Layer 2 VPN. MPLS should be enabled using the `enable mpls` command and LDP should be enabled using the `enable mpls protocol ldp` command.

Since the MPLS LSR ID is used as the local endpoint for PWs, it is highly desirable to create a loopback VLAN whose associated IP address is that of the MPLS LSR ID. The configured prefix length should be 32. As described in [“Establishing LDP LSPs to PW Endpoints” on page 1126](#), configuring this loopback VLAN for MPLS causes the address to be included in LDP address messages. Use the `configure mpls add vlan <vlan_name>` command for this. It is not required that LDP or MPLS be enabled on the VLAN for the address to be advertised by LDP. Use the `configure mpls ldp advertise direct lsr-id` command to initiate an LDP label mapping for an LDP LSP to the local endpoint.

Creating or Deleting a Layer 2 VPN Domain

To create a Layer 2 VPN, use the following command:

```
create l2vpn [vpls <vpls_name> | vpws <vpws_name>] fec-id-type pseudo-wire <pwid>
```

This command creates a named Layer 2 VPN instance. Multiple domains can be created, each representing a different L2 VPN. The `pwid` is a number that is used to signal and identify which Layer 2

VPN is associated with each pseudo wire. All of the pseudo wires carrying traffic for a specific Layer 2 VPN are signaled with the same `pwid`. No Layer 2 VPN traffic is forwarded over the Layer 2 VPN until at least one peer is added to the Layer 2 VPN and a service is associated with the Layer 2 VPN. The configured `pwid` also doubles as the Layer 2 VPN ID.

To delete a Layer 2 VPN, use the following command:

```
delete l2vpn [vpls [<vpls_name> | all] | vpws [<vpws_name> | all]]
```

This command deletes the named Layer 2 VPN instance or all Layer 2 VPN instances, depending on the keyword. All Layer 2 VPN peers and services associated with the deleted Layer 2 VPN instance(s) are also deleted.

Enabling or Disabling a Layer 2 VPN Domain

To enable a Layer 2 VPN, use the following command:

```
enable l2vpn [vpls [<vpls_name> | all] | vpws [<vpws_name> | all]]
```

This command enables a named Layer 2 VPN instance. By default, a newly created Layer 2 VPN is enabled.

To disable a Layer 2 VPN, use the following command:

```
disable l2vpn [vpls [<vpls_name> | all] | vpws [<vpws_name> | all]]
```

This command disables the named Layer 2 VPN instance. When a Layer 2 VPN is disabled, no traffic flows across the Layer 2 VPN. The pseudo wires connecting this peer to all other configured peers are also terminated, so the remote peers no longer see this LSR as an active peer.

Adding or Deleting a Layer 2 VPN Peer

To add a peer to the Layer 2 VPN, use the following command:

```
configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] add peer <ipaddress> {core  
{full-mesh | primary | secondary} | spoke}
```

For each new peer added, a pseudo wire is signaled to carry traffic for this Layer 2 VPN. Up to 64 peers can be added to a VPLS; and only one peer can be added to a VPWS. For each peer added, that remote peer must also configure this local LSR as a peer for the Layer 2 VPN. For VPLS configurations, this insures that the VPLS core is configured as a full mesh of VPLS peers.

The Layer 2 VPN names on each peer do not have to match since the pseudo wire ID is used to define the Layer 2 VPN to which each pseudo wire is associated.

To delete a peer from the Layer 2 VPN, use the following command:

```
configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] delete peer [<ipaddress> | all]
```

Once the peer is deleted, that specified peer is no longer a member of the Layer 2 VPN. For VPLS configurations, the peer must also be removed from all other VPLS peers to insure a proper full mesh and to prevent connectivity issues.

Adding or Deleting a Layer 2 VPN Service

To add a service to a Layer 2 VPN, use the following command:

```
configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] add service [{vlan} <vlan_name>
| {vman} <vman_name>]
```

Only one service can be added to each Layer 2 VPN. Traffic associated with the service is transported over the Layer 2 VPN. Three basic types of services are supported: VLAN, VMAN, and port. Both the VLAN and VMAN services are specified by adding the VLAN or VMAN name to the Layer 2 VPN. The port service is configured by adding a VMAN name to the Layer 2 VPN, configuring the Layer 2 VPN to strip the VMAN tag, and adding the port as *untagged* to the VMAN. This allows incoming service traffic to be transported across the Layer 2 VPN exactly as it was received. See “[Managing Layer 2 VPN Packet Forwarding Options](#)” on page 1180 for information about configuring a Layer 2 VPN to strip the VMAN tag.

To delete a service from a Layer 2 VPN, use the following command:

```
configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] delete service [{vlan}
<vlan_name> | {vman} <vman_name>]
```

Since there is no local service that needs to be connected to the Layer 2 VPN, the pseudo wires to each of the configured peers for this Layer 2 VPN are terminated.

Enabling or Disabling a Layer 2 VPN Service

To enable a Layer 2 VPN service, use the following command:

```
enable l2vpn [vpls [<vpls_name> | all] | vpws [<vpws_name> | all]] service
```

By default, any configured Layer 2 VPN service is enabled.

To disable a service from the Layer 2 VPN, use the following command:

```
disable l2vpn [vpls [<vpls_name> | all] | vpws [<vpws_name> | all]] service
```

When the service is disabled, the service is disconnected from the Layer 2 VPN and disabled such that no packets are sent to or received from the service. The pseudo wires to each of the configured peers for this Layer 2 VPN are terminated.

Managing Layer 2 VPN Packet Forwarding Options

To configure Layer 2 VPN packet forwarding options, use the following command:

```
configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] {dot1q [ethertype <hex_number> |
tag [include | exclude]]} {mtu <number>}
```

The options should be configured the same for every LSR for this Layer 2 VPN in order to prevent connectivity issues. Specifying the dot1q ethertype forces the switch to overwrite the dot1q ethertype value in the service packet. This can be used to interconnect two customer segments over the Layer 2 VPN that are using different configured ethertype values. By default, the dot1q tag in the service packet is not included. The switch can be configured to strip or exclude the dot1q tag. This can be used to emulate port services or for interoperability with equipment that may require tags.

To unconfigure Layer 2 VPN packet forwarding options, use the following command:

```
unconfigure l2vpn [vpls <vpls_name> | vpws <vpws_name>] dot1q ethertype
```

This command resets the dot1q ethertype for the specified Layer 2 VPN to the default ethertype configured for the switch.

Configuring the Layer 2 VPN MTU

The Maximum Transmission Unit (MTU) is the maximum packet size (excluding the data link header) that an interface can transmit. The Layer 2 VPN MTU defines the MTU for the customer facing interface. By default, the MTU size is set to 1500 bytes, which is the MTU size for standard Ethernet frames.

The frame size of the customer packet also includes the data link header and FCS field. The Ethernet data link header includes a minimum of a destination MAC address (six bytes), a source MAC address (six bytes), and an ethertype field (two bytes). The FCS field is four bytes. For a 1500-byte customer payload, the minimum customer frame size is 1518 bytes.

The Layer 2 frame, minus the FCS field, is encapsulated to form an MPLS packet to be transmitted to a Layer 2 VPN peer. This encapsulation adds another Ethernet header, an MPLS shim header, and a FCS field. The MPLS shim header usually includes two four-byte MPLS labels. Therefore, this encapsulation adds a minimum of 26 bytes.

The total frame size includes the customer payload, the Ethernet header on the customer facing interface (minimum 14 bytes), and the MPLS encapsulation (minimum 26 bytes). For a 1500-byte customer payload, the minimum Layer 2 VPN frame size is 1540 bytes.

The total frame size is restricted by the jumbo frame size. The maximum jumbo frame size that can be configured is 9216 bytes. If the customer payload in the above example is increased to 9176 bytes, the resulting Layer 2 VPN encapsulated frame size is 9216 bytes. Therefore, the maximum practical value of the Layer 2 VPN MTU is 9176 bytes.

There are additional considerations that can lower the maximum practical value of the Layer 2 VPN MTU setting. If the Layer 2 VPN is configured to include the VLAN tag of the customer interface, this increases the total frame size by four bytes. If the MPLS interface used to transmit the encapsulated Layer 2 VPN packet is a tagged VLAN, this also increases the total frame size by four bytes. If either of these configuration options is present, the maximum practical Layer 2 VPN MTU size is reduced accordingly.

To configure the Layer 2 VPN MTU size, use the `mtu` option in the following command:

```
configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] {dot1q [ethertype <hex_number> | tag [include | exclude]]} {mtu <number>}
```

The Layer 2 VPN MTU value is signaled to peers as part of the VC FEC information during PW setup. The local value must match the value received from the PW peer. If the two values do not match, the PW is not established.

Managing VPLS Redundancy Options

To configure VPLS redundancy options, use the following command:

```
configure {l2vpn} vpls <vpls_name> redundancy [esrp <esrpDomain> | eaps | stp]
```

To unconfigure VPLS redundancy options, use the following command:

```
unconfigure {l2vpn} vpls <vpls_name> redundancy [eaps | esrp | stp]
```

To display the configured VPLS redundancy option, use the following form of the `show l2vpn` command:

```
show l2vpn vpls {<vpls_name>} {peer <ipaddress>} detail
```

Displaying Layer 2 VPN Status

To display the status of all Layer 2 VPNs, a configured Layer 2 VPN, or a specific peer within a specific Layer 2 VPN, use the following command:

```
show l2vpn {vpls {<vpls_name>} | vpws {<vpws_name>}} {peer <ipaddress>} {detail} | summary}
```

Displaying Layer 2 VPN Statistics

To display statistics for Layer 2 VPNs, use the following command:

```
show mpls statistics l2vpn {<vpls_name> | <vpws_name> } {detail}
```

Managing Layer 2 VPN SNMP Traps

To enable or disable Layer 2 VPN SNMP traps, use the following commands:

```
enable snmp traps l2vpn
disable snmp traps l2vpn
```

To configure or remove a text-string identification for traps from a Layer 2 VPN, use the following commands:

```
configure vpls <vpls_name> snmp-vpn-identifier <identifier>
unconfigure vpls <vpls_name> snmp-vpn-identifier
```

To view the configured state for Layer 2 VPN SNMP traps, use the following command:

```
show mpls
```

VPLS VPN Configuration Examples

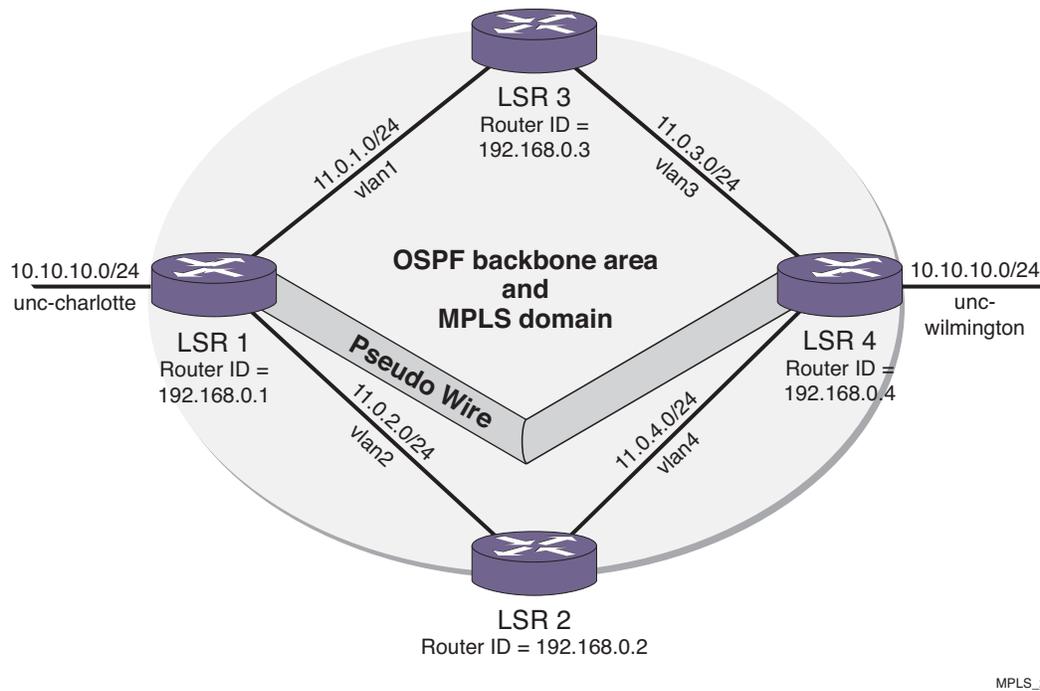
This section provides the following VPLS configuration examples:

- [Basic Point-to-Point VPLS Configuration Example on page 1182](#)
- [Multipoint Full Mesh VPLS Configuration Example on page 1183](#)
- [VPLS with Redundant EAPS Configuration Example on page 1185](#)

Basic Point-to-Point VPLS Configuration Example

This MPLS VPLS network configuration shown in [Figure 190](#), builds upon the routed MPLS network configuration example shown in [Figure 189](#).

Figure 190: MPLS VPLS Configuration Example



Assuming that the routed MPLS network has already been configured as in the previous example, the commands used to create the VPLS on LSR1 and LSR4 follow. The *nc-university-vpn* is a point-to-point VPLS, since only two peers are participating.

The following command creates the VPLS with VPN ID 35. This command must be issued on both LSR1 and LSR4:

```
create vpls nc-university-vpn fec-id-type pseudo-wire 35
```

On LSR1, the local VLAN service and the VPLS peer are configured:

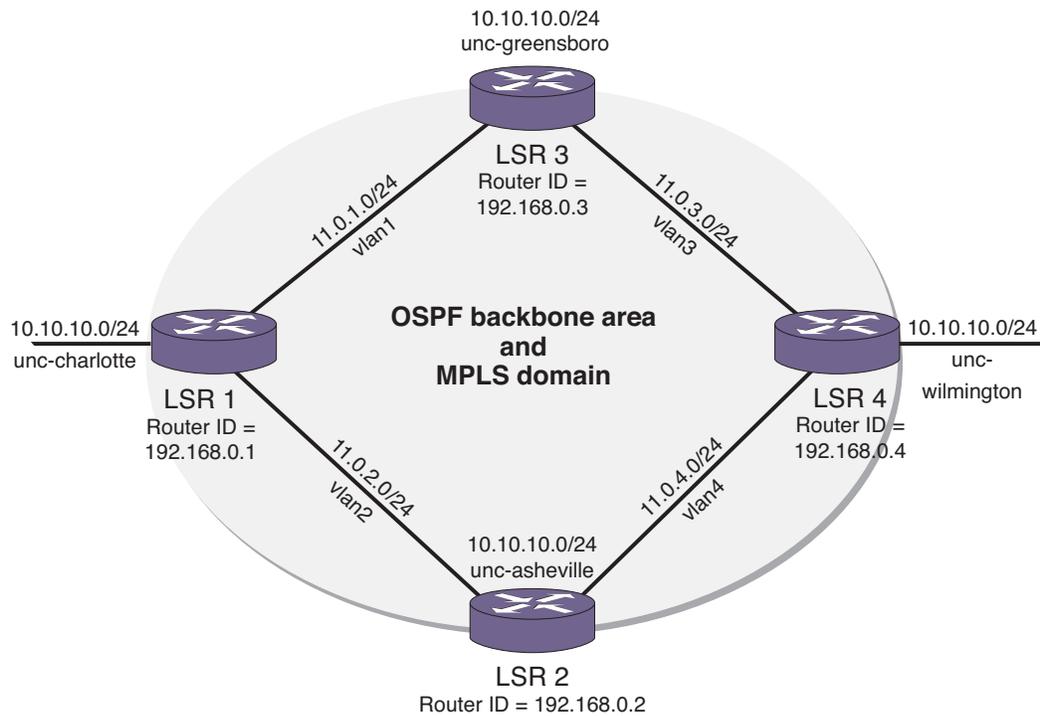
```
configure vpls nc-university-vpn add service vlan unc-charlotte
configure vpls nc-university-vpn add peer 192.168.0.4
```

On LSR4, the local VLAN service and the VPLS peer are also configured:

```
configure vpls nc-university-vpn add service vlan unc-wilmington
configure vpls nc-university-vpn add peer 192.168.0.1
```

Multipoint Full Mesh VPLS Configuration Example

The example shown in [Figure 191](#) configures a four node full-mesh MPLS VPLS configuration by adding two additional peers to the previous example.

Figure 191: Full Mesh Configuration Example

MPLS_29

LSR1

```
configure vpls nc-university-vpn add peer 192.168.0.2
configure vpls nc-university-vpn add peer 192.168.0.3
```

LSR2

```
create vpls nc-university-vpn fec-id-type pseudo-wire 35
configure vpls nc-university-vpn add peer 192.168.0.1
configure vpls nc-university-vpn add peer 192.168.0.3
configure vpls nc-university-vpn add peer 192.168.0.4
configure vpls nc-university-vpn add service vlan unc-asheville
```

LSR3

```
create vpls nc-university-vpn fec-id-type pseudo-wire 35
configure vpls nc-university-vpn add peer 192.168.0.1
configure vpls nc-university-vpn add peer 192.168.0.2
configure vpls nc-university-vpn add peer 192.168.0.4
configure vpls nc-university-vpn add service vlan unc-greensboro
```

LSR4

```
configure vpls nc-university-vpn add peer 192.168.0.2
configure vpls nc-university-vpn add peer 192.168.0.3
```

VPLS with Redundant EAPS Configuration Example

The following sections provide examples of how to configure switches to support the configuration described in “VPLS EAPS Redundancy Overview” on page 1140:

- [Core 1 Router Configuration on page 1185](#)
- [Core 2 Router Configuration on page 1185](#)

Core 1 Router Configuration

The following example shows the EAPS and VPLS configuration for the Core 1 router in the example in [Figure 183](#):

```
//create the EAPS protected VLAN and the VPLS service vlan

create vlan v1
configure v1 add ports 2:3 // port 2:3 is the port connected to dist 1

create eaps eaps2
configure eaps eaps2 mode transit
configure eaps eaps2 primary port 2:1 // port going to core 2
configure eaps eaps2 secondary port 2:3
configure eaps eaps2 add control vlan ctrl2 // eaps control vlan
configure eaps eaps2 add protected vlan v1

create eaps shared-port 2:1
configure eaps shared-port 2:1 mode controller
configure eaps shared-port 2:1 link-id 888
enable eaps2

create vpls vpls1 fec-id-type pseudo-wire 2
configure vpls vpls1 add service vlan v1
configure vpls vpls1 redundancy eaps
configure vpls vpls1 add peer <core2>
configure vpls vpls1 add peer <core3>
configure vpls vpls1 add peer <core4>
```

Core 2 Router Configuration

The following example shows the EAPS and VPLS configuration for the Core 2 router in the example in [Figure 183](#):

```
//create the EAPS protected VLAN and the VPLS service vlan

create vlan v1
configure v1 add ports 2:9 // port 2:9 is the port connected to dist 5

create eaps eaps2
configure eaps eaps2 mode transit
configure eaps eaps2 primary port 2:1 // port going to core 1
configure eaps eaps2 secondary port 2:9
configure eaps eaps2 add control vlan ctrl2
configure eaps eaps2 add protected vlan v1
```

```
create eaps shared-port 2:1
configure eaps shared-port 2:1 mode partner
configure eaps shared-port 2:1 link-id 888
enable eaps2
```

```
create vpls vpls1 fec-id-type pseudo-wire 2
configure vpls vpls1 add service vlan v1
configure vpls vpls1 redundancy eaps
configure vpls vpls1 add peer <core1>
configure vpls vpls1 add peer <core3>
configure vpls vpls1 add peer <core4>
```

Configuring H-VPLS

H-VPLS is configured at the edge of the network. The core of the network supports H-VPLS and is configured as described in “[Configuring MPLS Layer-2 VPNs \(VPLS and VPWS\)](#)” on page 1178. To configure H-VPLS, you need to configure the H-VPLS spoke nodes and the PE core nodes that peer with the spoke nodes. The following sections describe H-VPLS configuration tasks:

- [Configuring H-VPLS Spoke Nodes on page 1186](#)
- [Configuring H-VPLS Core Nodes on page 1186](#)
- [Configuring the MAC Address Withdrawal Feature on page 1187](#)
- [Displaying H-VPLS Configuration Information on page 1187](#)

Configuring H-VPLS Spoke Nodes

To configure an MTU as an H-VPLS spoke node, use the following command:

```
configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] add peer <ipaddress> {core
{full-mesh | primary | secondary} | spoke}
```

Use the `core primary` and `core secondary` command options as needed. The `core primary` option specifies that the spoke node peer is a core node and that the link between the peers is the primary spoke. The `core secondary` option specifies that the spoke node peer is a core node and that the link between the peers is the secondary spoke.

To delete an H-VPLS spoke node, use the following command:

```
configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] delete peer [<ipaddress> | all]
```

Configuring H-VPLS Core Nodes

To configure a VPLS core node as an H-VPLS core node, use the following command:

```
configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] add peer <ipaddress> {core
{full-mesh | primary | secondary} | spoke}
```

Use the `spoke` command option to specify that the peer is an H-VPLS spoke node. When the H-VPLS spoke and core peers are configured, VPLS communications can be established between them.

**NOTE**

To enable communications from the H-VPLS spoke across the VPLS network, the H-VPLS core node must also be configured to peer with the other VPLS nodes.

To delete an H-VPLS core node, use the following command:

```
configure l2vpn [vpls <vpls_name> | vpws <vpws_name>] delete peer [<ipaddress> | all]
```

Configuring the MAC Address Withdrawal Feature

The MAC address withdrawal feature is enabled by default. To disable this feature, use the following command:

```
disable l2vpn vpls fdb mac-withdrawal
```

To enable this feature after it has been disabled, use the following command:

```
enable l2vpn vpls fdb mac-withdrawal
```

Displaying H-VPLS Configuration Information

To display H-VPLS configuration information, use the following command:

```
show l2vpn {vpls {{<vpls_name>} | vpws {{<vpws_name>}} {peer <ipaddress>} {detail} | summary}
```

Configuring Protected VPLS

To configure a protected VPLS, use the following commands:

```
create esrp <esrp_domain> {type [vpls-redundancy | standard]}
configure {l2vpn} vpls <vpls_name> redundancy [esrp <esrpDomain> | eaps | stp]
```

To unconfigure a protected VPLS, use the following command:

```
unconfigure {l2vpn} vpls <vpls_name> redundancy [eaps | esrp | stp]
```

To display information about the protected VPLS, use the following command:

```
show esrp { {name} | {type [vpls-redundancy | standard]} }
```

Configuring RSVP-TE

This section describes the following tasks:

- [Enabling and Disabling RSVP-TE on the Switch on page 1188](#)
- [Enabling and Disabling RSVP-TE on a VLAN on page 1188](#)
- [Configuring RSVP-TE Protocol Parameters on page 1188](#)
- [Adding a Path to an RSVP-TE LSP on page 1192](#)
- [Creating an RSVP-TE Path on page 1189](#)

- [Configuring an Explicit Route on page 1190](#)
- [Reserving Bandwidth for MPLS on page 1191](#)
- [Creating and Deleting an RSVP-TE Profile on page 1191](#)
- [Configuring an RSVP-TE Profile on page 1192](#)
- [Adding a Path to an RSVP-TE LSP on page 1192](#)
- [Setting up Fast-Reroute Protection for an LSP on page 1193](#)

Enabling and Disabling RSVP-TE on the Switch

To enable RSVP-TE on a switch, use the following command:

```
enable mpls protocol rsvp-te
```

To disable RSVP-TE on a switch, use the following command:

```
disable mpls protocol rsvp-te
```



NOTE

MPLS must be globally enabled before RSVP-TE can become operational. For more information, see [“Enabling and Disabling MPLS on an LSR” on page 1160](#).

Enabling and Disabling RSVP-TE on a VLAN

To enable RSVP-TE on one or all VLANs, use the following command:

```
enable mpls rsvp-te [{vlan} <vlan_name> | vlan all]
```

To disable RSVP-TE on one or all VLANs, use the following command:

```
disable mpls rsvp-te te [{vlan} <vlan_name> | vlan all]
```

Disabling RSVP-TE on a VLAN causes all TE LSPs using that interface to be released, and prevents TE LSPs from being established or accepted on the specified VLAN.

Configuring RSVP-TE Protocol Parameters

To configure RSVP-TE protocol parameters, use the following command:

```
configure mpls rsvp-te timers session[{bundle-message-time
<bundle_message_milliseconds>} {hello-keep-multiplier <hello_keep_number>} {hello-time
<hello_interval_seconds>} {refresh-keep-multiplier <refresh_keep_number>} {refresh-time
<refresh_seconds>} {summary-refresh-time <summary_refresh_milliseconds>}] [{vlan}
<vlan_name> | vlan all]
```

This command configures the RSVP-TE protocol parameters for the specified VLAN. The RSVP-TE keyword `all` indicates that the configuration changes apply to all RSVP-TE enabled VLANs.

The `hello-interval` time specifies the RSVP hello packet transmission interval. The RSVP hello packet is used by the switch to detect when an RSVP-TE peer is no longer reachable. If an RSVP hello packet is not received from a peer within `[hello-interval * keep-multiplier]` seconds, the peer is declared down and all RSVP sessions to and from that peer are torn down. The default `hello-interval` time is zero,

indicating that RSVP hellos are not enabled. The hello-interval can be set to any value between zero and 60 seconds.

The `refresh-time` parameter specifies the interval for sending refresh path messages. RSVP refresh messages provide *soft state* link-level keep-alive information for previously established paths and enable the switch to detect when an LSP is no longer active. RSVP sessions are torn down if an RSVP refresh message is not received from a neighbor within $[(\text{keep-multiplier} + 0.5) * 1.5 * \text{refresh-time}]$ seconds. The default `refresh-time` is 30 seconds and the default `keep-multiplier` value is three. The minimum and maximum `refresh-time` values are one and 36,000 seconds (or ten hours), respectively. The minimum and maximum `keep-multiplier` values are one and 255, respectively.

The `bundle-time`, specified in tenths of a second, indicates the maximum amount of time a transmit buffer is held so that multiple RSVP messages can be bundled into a single PDU. The default `bundle-time` is zero, indicating that RSVP message bundling is not enabled. The `bundle-time` value can be set to any value between zero and 30 (or 3 seconds).

The `summary-refresh-time`, specified in tenths of a second, indicates the time interval for sending summary refresh RSVP messages. The `summary-refresh-time` must be less than the configured `refresh-time`. The default `summary-refresh-time` is zero, indicating that no summary refresh RSVP messages are sent. The `summary-refresh-time` value may be set to any value between zero to 100 (or 10 seconds).

If configured, the bundled and summary refresh RSVP messages are only sent to RSVP-TE peers supporting RSVP refresh reduction.

Creating or Deleting an RSVP-TE LSP

To create an RSVP-TE LSP, use the following command:

```
create mpls rsvp-te lsp <lsp_name> destination <ipaddress>
```

The `<lsp_name>` parameter is a character string that identifies the LSP within the switch. The `<lsp_name>` string must begin with an alphabetic character and can contain up to 31 additional alphanumeric characters. The LSP is not signaled until at least one path is added. See [“Adding a Path to an RSVP-TE LSP” on page 1192](#).

To delete an RSVP-TE LSP, use the following command:

```
delete mpls rsvp-te lsp [<lsp_name> | all]
```

Deleting an LSP name disassociates all configured paths with this LSP and all configuration information for the LSP name is deleted. If the LSP has been specified for use by a static route or a VPLS, that configuration information is also deleted. If you specify the `all` keyword, all LSPs are deleted.

Creating an RSVP-TE Path

To create an RSVP-TE routed path resource, use the following command:

```
create mpls rsvp-te path <path_name>
```

The `<path_name>` parameter is a character string that is to used to identify the path within the switch. The `<path_name>` string must begin with an alphabetic character, and can contain up to 31 additional alphanumeric characters. The RSVP-TE LSP is not signaled along the path until an LSP adds the specified path name. The maximum number of configurable paths is 255.

To delete an RSVP-TE path, use the following command:

```
delete mpls rsvp-te path [<path_name> | all]
```

This command deletes a configured MPLS RSVP-TE routed path with the specified `<path_name>`. All associated configuration information for `<path_name>` is deleted. A path cannot be deleted as long as the `<path_name>` is associated with an LSP. If the `all` keyword is specified, all paths not associated with an LSP are deleted.

Configuring an Explicit Route

To add an RSVP-TE explicit route, use the following command:

```
configure mpls rsvp-te path <path_name> add ero <ipNetmask> [strict | loose] {order <number>}
```

This command adds an IP address to the explicit route object (ERO) for the specified path name. The RSVP-TE routed path can be described by a configured sequence of the LSRs and/or subnets traversed by the path. Each defined LSR or subnet represents an ERO subobject. Up to 64 subobjects can be added to each path name.

The `ipaddress` keyword identifies an LSR using either a /32 address, which may represent an LSR router ID, loopback address, or direct router interface, or an IP prefix, which represents a directly connected subnet. Each IP address or prefix is included in the ERO as an IPv4 subobject.

If the IP address is specified as `strict`, the strict subobject must be topologically¹ adjacent to the previous subobject as listed in the ERO. If the IP address is specified as `loose`, the loose subobject is not required to be topologically adjacent to the previous subobject as listed in the ERO. If omitted, the default subobject attribute is `loose`. Each IP address or prefix is included in the ERO as an IPv4 subobject.

If the subobject matches a direct router interface or a directly attached subnet, the switch verifies that the path message is received on the matching router interface.

The LSR path order is optionally specified using the `order` keyword. The `order number` parameter is an integer value from 1 to 65535. IP prefixes with a lower order number are sequenced before IP prefixes with a higher number. You can specify multiple addresses and assign them an order number. The order number determines the path that the LSP follows. Thus, the LSP follows the configured path of the IP prefix with the order value from low to high. If the `order` keyword is not specified, the number value for the LSR defaults to a value 100 higher than the current highest number value.

If the list of IP prefixes added to the path does not reflect an actual path through the network topology, the path message is returned with an error from a downstream LSR and the LSP is not established.

The order of a configured subobject can not be changed. The ERO subobject must be deleted and re-added using a different order. If a subobject is added to or deleted from the ERO while the associated LSP is established, the path is torn down and is resigaled using the new ERO.

Duplicate ERO subobjects are not allowed. Defining an ERO for the path is optional. If you do not configure an ERO, the path is signaled along the best CSPF calculated path and the ERO is not included in the path message. When the last subobject in the ERO of the path message is reached and the egress IP node of the path has not been reached, the remaining path to the egress node is signaled along the best CSPF calculated path. Specification of an ERO could lead to undesirable routed paths, so care

1. The LSP next hop matches the interface IP address of the immediate neighbor LSR.

should be taken when terminating the ERO routed-path definition prior to the configured path egress node.

To delete an RSVP-TE explicit route, use the following command:

```
configure mpls rsvp-te path <path_name> delete ero [all | <ipNetmask> | order <number>]
```

This command deletes an LSR or subnet from the ERO for the specified path name. The LSR is specified using the `ipaddress`, or `order` parameter. If an LSR is deleted from an ERO while the associated LSP is established, the path is torn down and is resigaled using a new ERO. Use the `all` keyword to delete the entire ERO from the path name. When there is no configured ERO, the path is no longer required to take an explicit routed path. The path is then signaled along the best CSPF calculated path and no ERO is included in the path message.

Reserving Bandwidth for MPLS

In order to manage the bandwidth used by MPLS RSVP-TE LSPs, a configured amount of bandwidth must be reserved for MPLS. Bandwidth in the transmit direction must be reserved on all MPLS interfaces which will be used as egress interfaces for RSVP-TE LSPs requesting bandwidth. Bandwidth in the receive direction can be optionally reserved on all MPLS interfaces that will be used as ingress interfaces for RSVP-TE LSPs requesting bandwidth. Note that the receive bandwidth reservation can be exceeded, and is provided only for tracking and informational purposes.

The following command is used to reserve bandwidth for MPLS:

```
configure mpls rsvp-te bandwidth committed-rate <committed_bps> [Kbps | Mbps | Gbps] [{vlan} <vlan_name> | vlan all] {receive | transmit | both}
```

The `committed_rate_unit` must be specified in Kbps, Mbps, or Gbps. Choosing the `vlan all` option reserves the specified amount of bandwidth on all MPLS interfaces.

The default reserved value is zero. Therefore, no LSPs requesting bandwidth can be established until the bandwidth has been configured.

Creating and Deleting an RSVP-TE Profile

To create a traffic engineered LSP profile, use the following command:

```
create mpls rsvp-te profile <profile_name> {standard}
```

This command creates a configured RSVP-TE profile with the specified profile name. The *default* profile cannot be deleted. If a profile is associated with a configured LSP, the profile cannot be deleted.

To delete a traffic engineered LSP profile, use the following command:

```
delete mpls rsvp-te profile [<profile_name> | all]
```

Configuring an RSVP-TE Profile

To configure an RSVP-TE profile, use the following command:

```
configure mpls rsvp-te profile <profile_name> {bandwidth [best-effort | [{committed-
rate <committed_bps> [Kbps | Mbps | Gbps]] {max-burst-size <burst_size> [Kb | Mb]}
{peak-rate <peak_bps> [Kbps | Mbps | Gbps]}}] {hold-priority <hold_priority>} {mtu
[<number> | use-local-interface]} {record [enabled {route-only} | disabled]} {setup-
priority <setup_priority>}
```

A profile is a set of attributes that are applied to the LSP when the LSP is configured using the `create mpls rsvp-te lsp` command. A default profile is provided which cannot be deleted, but can be applied to any configured LSP. The profile name for the default profile is *default*. The default profile parameter values are initially set to their respective default values. The maximum number of configurable profiles is 255 (one of which is reserved for the default profile).

The `bandwidth` parameter specifies the desired reserved bandwidth for the LSP. Any positive integer value is valid. You must append the characters k for kilobits, m for megabits, or g for gigabits, to the bps value to specify the unit of measure. The default bandwidth bps value is zero, which indicates that the QoS for the LSP is best effort.

The `max-burst-size` and `peak-rate` parameters are signaled in the sender Tspec object and add further definition of the expected traffic. The `mtu` parameter is also signaled in the sender Tspec object and defines the expected maximum packet size that is sent over the LSP.

The `setup-priority` and `hold-priority` are optional parameters indicating the LSP priority. During path set up, if the requested bandwidth cannot be reserved through the LSR, the `setup-priority` parameter is compared to the `hold-priority` of existing LSPs to determine if any of the existing LSPs need to be preempted to allow a higher priority LSP to be established. Lower numerical values represent higher priorities. The `setup-priority` range is 0 to 7 and the default value is 7. The `hold-priority` range is also 0 to 7 and the default value is 0.

The `record` keyword is used to enable hop-by-hop path recording. The `enabled` keyword causes the record route object (RRO) to be inserted into the path message. The RRO is returned in the reserve message and contains a list of IPv4 subobjects that describe the RSVP-TE path. Path recording by default is disabled. When disabled, no RRO is inserted into the path message.

To delete an RSVP-TE path profile, use the following command:

```
delete mpls rsvp-te profile [<profile_name> | all]
```

This command deletes a configured RSVP-TE profile with the specified profile name. The default profile cannot be deleted. If a profile is associated with a configured LSP, the profile cannot be deleted. If you specify the `all` keyword, all profiles not associated with an LSP are deleted (except for the default profile).

Adding a Path to an RSVP-TE LSP

To add a path to an RSVP-TE LSP, use the following command:

```
configure mpls rsvp-te lsp <lsp_name> add path [<path_name> | any] {profile
<profile_name>} {primary {<frr_profile_name>} | secondary}
```

This command adds a configured path to the specified RSVP-TE LSP. The LSP name parameter is a character string that is to be used to identify the LSP within the switch and must have been created previously. The LSP is not signaled until a path is added to the LSP. Up to three paths can be defined for the LSP: one primary and two secondary. All paths are signaled, but only one path is used to

forward traffic at any one time. The switch chooses the local MPLS VLAN interface from which to signal the LSP. To force an LSP to use a specific local MPLS interface, configure the peer's interface IP address as the first ERO in the associated path. The profile name is optional. If omitted, the default profile is applied to the LSP. The path name can be specified or the LSP can be configured to take any path. For a given LSP, only one path can be configured to take any path through the MPLS network.

The specified path defaults to primary when no primary path has been configured for the LSP and defaults to secondary if the primary path has been previously configured for the LSP.

Each <path_name> added to an <lsp_name> must be unique, but a <path_name> can be associated with multiple LSP names.

All configured primary and secondary paths for the <lsp_name> must have the same endpoint IP address. For example, three paths can be configured for the <lsp_name>, but all paths should represent different topological paths through the network to the same LSP endpoint.

Adding a secondary <path_name> designates a path as a hot-standby redundant path, used in the event that the primary or the other secondary path cannot be established or fails. Provided the <path_name> has not already been established, all paths are signaled as soon as they are associated with an <lsp_name>. If the primary <path_name> fails, is not configured, or cannot be established after the specified LSP retry-timeout, one of the configured secondary paths becomes the active path for <lsp_name>. All of the secondary paths have equal preference; the first one available is chosen. If at any time the primary path is reestablished, <lsp_name> immediately switches to using the primary path. If a secondary path fails while in use, the remaining configured secondary path can become the active path for <lsp_name>.

To delete a path from an RSVP-TE LSP, use the following command:

```
configure mpls rsvp-te lsp <lsp_name> delete path [<path_name> | any | all]
```

When you issue this command, the LSP associated with the path is immediately torn down. If the deleted path represents the in-use LSP for <lsp_name> and another secondary path is configured, the LSP immediately fails over to an alternate LSP. Because at least one path must be defined for each LSP, the last configured path cannot be deleted from the LSP.

Setting up Fast-Reroute Protection for an LSP

To create a protected LSP, do the following:

- 1 Create the LSP as described in “[Creating or Deleting an RSVP-TE LSP](#)” on page 1189.
- 2 Enable the fast-reroute feature on the LSP using the following command:


```
configure mpls rsvp-te lsp <lsp_name> fast-reroute [enable | disable]
```
- 3 Create a path for the LSP as described in “[Creating an RSVP-TE Path](#)” on page 1189.
- 4 Define the path route as described in “[Configuring an Explicit Route](#)” on page 1190.
- 5 If you want to use a custom profile instead of the default profile, create a profile for the protected LSP as described in “[Creating and Deleting an RSVP-TE Profile](#)” on page 1191.
- 6 If you want to configure the custom profile created in the previous step, configure the profile as described in “[Configuring an RSVP-TE Profile](#)” on page 1192.
- 7 If you want to use a custom fast-reroute profile instead of using the default fast-reroute profile, create the profile using the following command at the ingress LER:

```
create mpls rsvp-te profile <profile_name> fast-reroute
```

- 8** If you want to configure the custom fast-reroute profile created in the previous step, use the following command at the ingress LER:

```
configure mpls rsvp-te profile <frr_profile_name> {bandwidth <bandwidth_rate_bps>
<bandwidth_rate_unit>} {detour {hop-limit <hop_limit_value>} {bandwidth-protection
[enabled | disabled]} {node-protection [enabled | disabled]}} {hold-priority
<hold_priority_value>} {setup-priority <setup_priority_value>}
```

- 9** Add the path to the protected LSP and select the standard and fast-reroute profiles using the following command:

```
configure mpls rsvp-te lsp <lsp_name> add path [<path_name> | any] {profile
<profile_name>} {primary {<frr_profile_name>} | secondary}
```

RSVP-TE Configuration Example

RSVP-TE LSPs comprise profiles, paths, and the actual LSP. This section describes how to configure an RSVP-TE LSP.

Configuring RSVP LSPs is a multi-step process with some optional steps, depending on the specific requirements of the LSP. Conceptually, a number of mandatory elements must be configured to create an RSVP-TE LSP. In addition, you can also configure optional elements. In certain configurations, there are also order dependencies.

The profile contains constraints that you might wish to apply to the LSP. These constraints can affect the path selected across the MPLS domain in order to meet those constraints. Examples of profile parameters include bandwidth, setup, and hold priority relative to other configured LSPs.

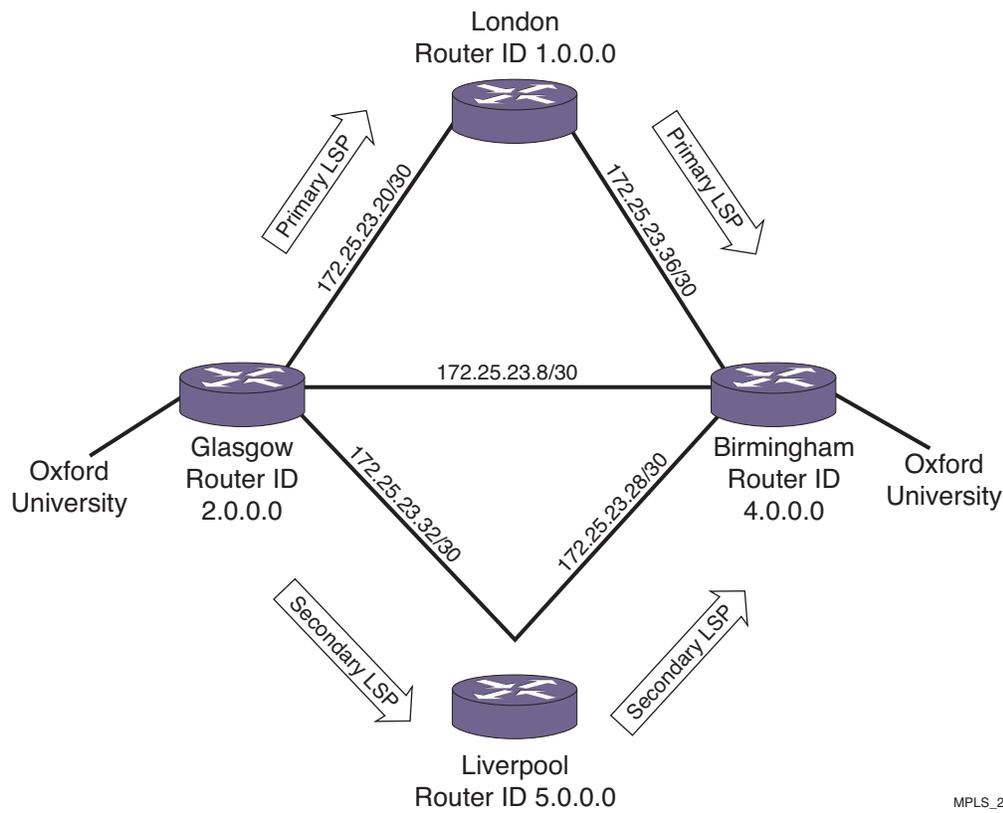
The path can be used to specify the explicit path across the MPLS domain that the LSP should follow. This is done using EROs. An ERO is an object, sent as part of the LSP setup request (path message) that explicitly specifies the part of the path across the MPLS domain the setup request should follow. You can configure both loose and strict EROs in a path.

Certain elements of configuration are order dependent. For example if you specify a profile or path when creating an LSP, those path or profile definitions must already exist. Similarly a path must exist before an ERO is created, as the ERO is added explicitly to the path.

The typical steps used to configure and verify an RSVP-TE LSP are as follows:

- 1** Create and configure a path (optional).
- 2** Reserve bandwidth for the LSP (optional).
- 3** Create and configure a profile (optional).
- 4** Create an LSP (mandatory).
- 5** Add a primary/secondary path to the LSP (mandatory).
- 6** Add a secondary path to the LSP (optional).
- 7** Verify LSP status (recommended).

Figure 192: RSVP-TE Configuration Example



MPLS_24

The configuration example, shown in Figure 192, creates primary and secondary LSPs between the node Glasgow and the node Birmingham. The steps specifically create an LSP between Glasgow and Birmingham based on an explicitly routed path via London with bandwidth, setup priority, and hold priority profile requirements. A secondary path is also created which, in the event of failure of a link or node on the primary path, activates the secondary LSP from Glasgow to Liverpool to Birmingham.

**NOTE**

Before configuring RSVP-TE LSPs, you need to enable the protocol on the switch, and an initial step of adding RSVP-TE to a VLAN must be carried out for all VLANs over which the user wishes RSVP-TE LSPs to be signaled. This is a one-time operation.

**NOTE**

A loopback VLAN with the LSR-ID should be added to MPLS to allow RSVP-TE LSPs to be established to the LSR-ID.

The following commands configure RSVP-TE for the switch and add RSVP signaling capabilities to the specified VLANs:

```
enable mpls
enable mpls protocol rsvp-te
configure mpls add vlan loopback
configure mpls add vlan gla-lon
```

```
enable mpls rsvp-te vlan gla-lon
enable mpls vlan gla-lon
configure mpls add vlan gla-liv
enable mpls rsvp-te vlan gla-liv
enable mpls vlan gla-liv
```

The following commands reserve bandwidth for RSVP-TE LSPs on these MPLS interfaces:

```
configure mpls rsvp-te bandwidth committed-rate 20 Mbps gla-lon
configure mpls rsvp-te bandwidth committed-rate 20 Mbps gla-liv
```

The following commands create and configure an LSP profile named Glasgow-Birmingham-pro. LSPs that use the Glasgow-Birmingham-pro profile are signaled with a reserved bandwidth of 10 Mbps and an LSP setup and hold priority of 5.

```
create mpls rsvp-te profile Glasgow-Birmingham-pro
configure mpls rsvp-te profile Glasgow-Birmingham-pro bandwidth committed-rate 10 m
configure mpls rsvp-te profile Glasgow-Birmingham-pro setup-priority 5 hold-priority 5
```

The following commands define the primary and secondary paths between Glasgow and Birmingham:

```
create mpls rsvp-te path Glasgow-Birmingham-pri-path
create mpls rsvp-te path Glasgow-Birmingham-sec-path
```

The following commands pin each path to an LSR, such that each path takes a different route to the endpoint 4.0.0.0. Path Glasgow-Birmingham-pri-path is routed through LSR 1.0.0.0 and path Glasgow-Birmingham-sec-path is routed through LSR 5.0.0.0.

```
configure mpls rsvp-te path Glasgow-Birmingham-pri-path add ero 1.0.0.0/32 loose
configure mpls rsvp-te path Glasgow-Birmingham-sec-path add ero 5.0.0.0/32 loose
```

The following commands create one RSVP-TE LSP with one primary and one secondary or backup path. Each path uses the same profile.

```
create mpls rsvp-te lsp Glasgow-Birmingham-lsp destination 4.0.0.0
configure mpls rsvp lsp Glasgow-Birmingham-lsp add path Glasgow-Birmingham-pri-path
profile Glasgow-Birmingham-pro primary
configure mpls rsvp lsp Glasgow-Birmingham-lsp add path Glasgow-Birmingham-sec-path
profile Glasgow-Birmingham-pro secondary
```



NOTE

The secondary LSP is signaled, however it remains in a standby state unless the primary path becomes unavailable.

By default, a VPLS pseudo wire flows over any available LSP. However, a VPLS pseudo wire can be specifically directed to use a configured RSVP-TE based LSP. Configuration is no different from configuring an LDP-based VPLS pseudo wire, except that the RSVP-TE LSP is explicitly specified. The following command specifically directs a VPLS pseudo wire to use a previously configured RSVP-TE LSP:

```
configure vpls Glasgow-Birmingham-cust1 peer 4.0.0.0 add mpls lsp Glasgow-Birmingham-lsp
```

Troubleshooting MPLS

The ExtremeXOS software includes multiple mechanisms for detecting and reporting problems. Many failures generate an SNMP trap or log an error message. To find out more about a problem, you can enter `show` commands and review the flag states in the command output. The software also includes some MPLS troubleshooting tools, which are described in the following sections:

- [Using LSP Ping on page 1197](#)
- [Using LSP Trace on page 1197](#)
- [Using the Health Check VCCV Feature on page 1198](#)

Using LSP Ping

To assist with problem determination in an MPLS network, LSP ping support is included as a CLI ping option in the ExtremeXOS software. The LSP ping support is based on *draft-ietf-mpls-lsp-ping-13.txt*. This draft includes support for both connectivity verification and fault isolation for transport LSPs. Connectivity verification is supported using a modified *ping* packet that is sent over the specified transport LSP.

LSP ping is designed to catch failures where a transport LSP appears to be operational but is in fact not functioning correctly. LSP data plane corruption is far less likely to occur than an LSP control plane failure, but the LSP ping is also useful for detecting possible latency issues.

To send MPLS ping packets over an LSP, enter the command:

```
ping mpls lsp [<lsp_name> | any <host> | prefix <ipNetmask>] {reply-mode [ip | ip-
router-alert]} {continuous | count <count>} {interval <interval>} {start-size <start-
size> {end-size <end-size>}} {ttl <ttl>} {{from <from>} {next-hop <hopaddress>}}
```

MPLS pings are sent to the well-known UDP port number 3503 with an IP in the 127.0.0.0/8 IP subnet. The source IP address is set to the sender.

The time stamp field is supported for calculating round trip times and is accurate to 1/100 of a second. When replying to a ping, the LSP ping response (MPLS echo reply) sequence number and time-stamp fields are set to the LSP ping request (MPLS echo request) values. One MPLS echo response is sent for each MPLS echo request received. An MPLS echo reply is sent out-of-band as a natively IP routed IPv4 UDP packet. The normal IP routed path might or might not use an LSP.

To reduce the possibility of fragmentation problems on the return path, MPLS echo reply packets do not include any padding that was sent in the MPLS echo request. Because each LSP is unidirectional, the return path is not directly relevant for verification of the LSP's functionality. What is important is that the LSP ping results are returned to the source of the MPLS echo request.

Using LSP Trace

Transport LSP fault isolation is supported using the LSP trace feature. When the control plane detects a transport LSP failure, the LSR can switch to another LSP if one is available. When the failure is detected by LSP ping, you can use LSP trace to try to isolate the fault.

To start an LSP trace, enter the following command:

```
traceroute mpls lsp [<lsp_name> | any <host> | prefix <ipNetmask>] {reply-mode [ip |
ip-router-alert]} {{from <from>} {ttl <ttl>} {next-hop <hopaddress>}}
```

Using the Health Check VCCV Feature

Health check Virtual Circuit Connectivity Verification (VCCV) can be used as a network diagnostic tool or as a network fault-alert tool, and can be configured on up to 16 VPLS domains.

Connectivity between VPLS peers can be verified using the health check VCCV feature, which is defined in RFC 5085, Pseudowire Virtual Circuit Connectivity Verification (VCCV). This implementation uses the following components defined in that RFC:

- VCCV Control Channel Type: MPLS Router Alert Label
- VCCV Control Verification Type: LSP Ping

Health check uses the LSP ping capability to verify connectivity. When the PW is set up, the two peers negotiate the VCCV capabilities, and if they establish a common set, health check becomes operational. If the VCCV capabilities do not match, health check cannot operate.

Health check operates in a single direction, so health checking should be enabled on the LSRs at both ends of the pseudo wire in order to verify that traffic can flow bi-directionally between two VPLS peers. For multi-peer full-mesh or hierarchical VPLS networks, VCCV should be enabled on all VPLS peers to verify the entire VPLS network.

VCCV sends health check packets at regular intervals (the default interval is 5 seconds). If health check reaches the threshold for missed responses (the default fault-multiplier is 4), health check logs a message in EMS at the Warning level. Note that this log is not seen with the default log settings and no SNMP traps are sent. A health check failure does not change the state of the PW, which could remain operationally up and continue to support traffic, depending on the actual problem.

To enable health check, enter the command:

```
enable l2vpn [vpls <vpls_name> | vpws <vpws_name>] health-check vccv
```

To configure health check, enter the command:

```
configure l2vpn [vpls [<vpls_name> | all] | vpws [<vpws_name> | all]] health-check vccv {interval <interval_seconds>} {fault-multiplier <fault_multiplier_number>}
```

To view VPLS configuration information, including the health check feature configuration, enter the command:

```
show l2vpn {vpls {{<vpls_name>}} | vpws {{<vpws_name>}}} {peer <ipaddress>} {detail} | summary}
```

To disable health check, enter the command:

```
disable l2vpn [vpls [<vpls_name> | all] | vpws [<vpws_name> | all]] health-check vccv
```

31

CHAPTER

IPv4 Unicast Routing

This chapter includes the following sections:

- [Overview on page 1254](#)
- [Configuring Unicast Routing on page 1271](#)
- [Displaying the Routing Configuration and Statistics on page 1275](#)
- [Routing Configuration Example on page 1277](#)
- [Duplicate Address Detection on page 1279](#)
- [Proxy ARP on page 1282](#)
- [IPv4 Multinetting on page 1283](#)
- [DHCP/BOOTP Relay on page 1289](#)
- [Broadcast UDP Packet Forwarding on page 1293](#)
- [IP Broadcast Handling on page 1296](#)
- [VLAN Aggregation on page 1297](#)

This chapter assumes that you are already familiar with IP unicast routing. If not, refer to the following publications for additional information:

- RFC 1256—*ICMP Router Discovery Messages*
- RFC 1812—*Requirements for IP Version 4 Routers*



NOTE

For more information on interior gateway protocols, see [Chapter 33, “RIP,”](#) [Chapter 35, “OSPF,”](#) and [Chapter 37, “IS-IS.”](#) For information on exterior gateway protocols, see [Chapter 38, “BGP.”](#) For more information on switch support for IPv6, see [Chapter 32, “IPv6 Unicast Routing.”](#)

Overview

The switch provides full Layer 3, IPv4 unicast routing to all switches that run the Edge, Advanced Edge, and Core licenses (see [Appendix A, “Feature License Requirements”](#)). It exchanges routing information with other routers on the network using one of the following routing protocols:

- Routing Information Protocol (RIP)
- Open Shortest Path First (OSPF)
- Border Gateway Protocol (BGP)
- Intermediate System-Intermediate System (ISIS)

The switch dynamically builds and maintains a set of routing tables and determines the best path for each of its routes. Each host using the IP unicast routing functionality of the switch must have a unique IP address assigned. In addition, the default gateway assigned to the host must be the IP address of the router interface.

The ExtremeXOS software can provide both IPv4 and IPv6 routing at the same time. Separate routing tables are maintained for the two versions. Most commands that require you to specify an IP address can now accept either an IPv4 or IPv6 address and act accordingly. Additionally, many of the IP configuration, enabling, and display commands have added tokens for IPv4 and IPv6 to clarify the version required. For simplicity, existing commands affect IPv4 by default and require you to specify IPv6, so configurations from an earlier release still correctly configure an IPv4 network.

The following sections provide additional information on IP unicast routing:

- [Router Interfaces on page 1254](#)
- [Populating the Routing Tables on page 1255](#)
- [Hardware Routing Table Management on page 1262](#)

Router Interfaces

The routing software and hardware routes IP traffic between router interfaces. A router interface is simply a virtual LAN (VLAN) that has an IP address assigned to it.

As you create VLANs with IP addresses belonging to different IP subnets, you can also choose to route between the VLANs. Both the VLAN switching and IP routing function occur within the switch.

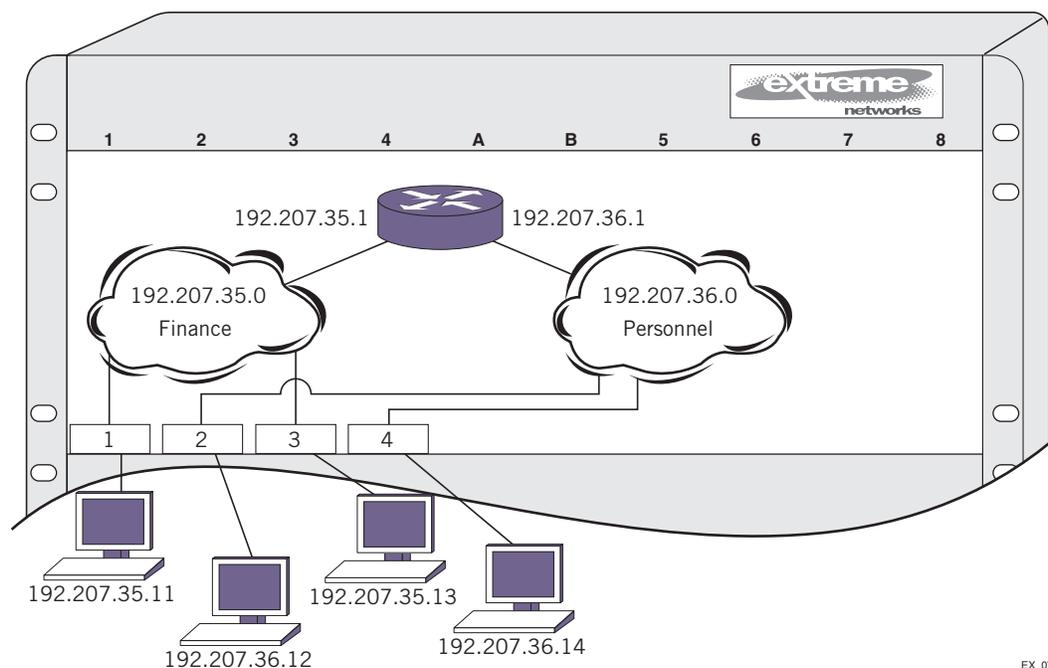


NOTE

Each IP address and mask assigned to a VLAN must represent a unique IP subnet. You cannot configure the same IP address and subnet on different VLANs.

[Figure 207](#) shows an example BlackDiamond switch configuration with two VLANs defined; *Finance* and *Personnel*. All ports on slots 1 and 3 are assigned to *Finance*, and all ports on slots 2 and 4 are assigned to *Personnel*. [Figure 207](#) shows the subnet address and interface address for each VLAN. Traffic within each VLAN is switched using the Ethernet MAC addresses. Traffic between the two VLANs is routed using the IP addresses.

Figure 193: Routing Between VLANs



EX_070

Populating the Routing Tables

The switch maintains a set of IP routing tables for both network routes and host routes. Some routes are determined dynamically from routing protocols, and some routes are manually entered. When multiple routes are available to a destination, configurable options such as route priorities, route sharing, and compressed routes are considered when creating and updating the routing tables. This section presents the following topics:

- [Dynamic Routes on page 1255](#)
- [Static Routes on page 1256](#)
- [Multiple Routes on page 1256](#)
- [Relative Route Priorities on page 1257](#)
- [IP Route Sharing and ECMP on page 1257](#)
- [Compressed Routes on page 1258](#)

Dynamic Routes

Dynamic routes are typically learned by enabling the RIP, OSPF, IS-IS or BGP protocols, and are also learned from Internet Control Message Protocol (ICMP) redirects exchanged with other routers. These routes are called *dynamic routes* because they are not a permanent part of the configuration. The routes are learned when the router starts up and are dynamically updated as the network changes. Older dynamic routes are aged out of the tables when an update for the network is not received for a period of time, as determined by the routing protocol.

Once a routing protocol is configured, dynamic routes require no configuration and are automatically updated as the network changes.

Static Routes

Static routes are routes that are manually entered into the routing tables and are not advertised through the routing protocols. Static routes can be used to reach networks that are not advertised by routing protocols and do not have dynamic route entries in the routing tables. Static routes can also be used for security reasons, to create routes that are not advertised by the router.

Static routes are configured in the ExtremeXOS software, remain part of the configuration when the switch is rebooted, and are immediately available when the switch completes startup. Static routes are never aged out of the routing table, however, the Bidirectional Forwarding Detection (BFD) feature, (see “[Bidirectional Forwarding Detection \(BFD\)](#)” on page 432) can be used to bring down static routes when the host link fails.

Without BFD, static routes always remain operationally active because there is no dynamic routing protocol to report network changes. This can lead to a black hole situation, where data is lost for an indefinite duration. Because upper layer protocols are unaware that a static link is not working, they cannot switch to alternate routes and continue to use system resources until the appropriate timers expire.

With BFD, a static route is marked operationally inactive if the BFD session goes down. Upper layer protocols can detect that the static route is down and take the appropriate action.

A *default route* is a type of static route that identifies the default router interface to which all packets are routed when the routing table does not contain a route to the packet destination. A default route is also called a default gateway.

Multiple Routes

When there are multiple, conflicting choices of a route to a particular destination, the router picks the route with the longest matching network mask. If these are still equal, the router picks the route using the following default criteria (in the order specified):

- Directly attached network interfaces
- Static routes
- ICMP redirects
- Dynamic routes
- Directly attached network interfaces that are not active.

You can also configure *blackhole* routes—traffic to these destinations is silently dropped.

The criteria for choosing from multiple routes with the longest matching network mask is set by choosing the relative route priorities.

Relative Route Priorities

Table 128 lists the relative priorities assigned to routes depending on the learned source of the route.



NOTE

You can change the order of the relative priorities, but we recommend that you only make changes if you are aware of the possible consequences.

Table 117: Relative Route Priorities

Route Origin	Priority
Direct	10
BlackHole	50
Static	1100
ICMP	1200
EBGP	1700
IBGP	1900
OSPFIntra	2200
OSPFInter	2300
IS-IS	2350
IS-IS L1	2360
IS-IS L2	2370
RIP	2400
OSPFExtern1	3200
OSPFExtern2	3300
IS-IS L1Ext	3400
IS-IS L2Ext	3500
BOOTP	5000

IP Route Sharing and ECMP

IP route sharing allows a switch to communicate with a destination through multiple equal-cost routes. In OSPF, BGP, and IS-IS, this capability is referred to as equal cost multipath (ECMP) routing.

Without IP route sharing, each IP route entry in the routing tables lists a destination subnet and the next-hop gateway that provides the best path to that subnet. Every time a packet is forwarded to a particular destination, it uses the same next-hop gateway.

With IP route sharing, an additional ECMP table lists up to 2, 4, or 8 next-hop gateways (depending on the platform and feature configuration) for each route in the routing tables. When multiple next-hop gateways lead to the same destination, the switch can use any of those gateways for packet forwarding. IP route sharing provides route redundancy and can provide better throughput when routes are overloaded.

The gateways in the ECMP table can be defined with static routes, or they can be learned through the OSPF, BGP, or IS-IS protocols. For more information on the ECMP table, see [“ECMP Hardware Table” on page 1269](#).



NOTE

BGP does not use ECMP by default, so if you require that functionality you must explicitly issue the `configure bgp maximum-paths <max-paths>` command with a value greater than 1.

Compressed Routes

Compressed routes allow you to reduce the number of routes that are installed in the hardware routing tables. The switch uses hardware routing tables to improve packet forwarding performance. The switch can use both hardware and software to forward packets, but packet forwarding without software processing is faster. The hardware routing tables have less storage space than the software, so compressed routes conserve resources and improve scaling.

The compressed route feature allows you to install less specific routes in the table, when overlapping routes with same nexthop exist. This route pruning technique is implemented as part of the Route Manager (RtMgr) process.

When a route is added, deleted or updated, the pruning algorithm is applied to see if the new route and/or its immediate children can be compressed or uncompressed as follows:

- If the parent node (immediate less specific route) of the newly added IP prefix has the same gateway as the new IP prefix, the newly added prefix is compressed.
- If the gateways of the newly added IP prefix and its immediate children are the same, the child nodes are compressed.
- If the gateways of the newly added IP prefix and its immediate children are not the same, and the child nodes had been previously compressed, the child nodes are uncompressed.

Event Log Messages. Event log messages are given in the following circumstances:

- When compression or uncompression start and end.

[Severity level: Debug -Summary]

- During each chunking start and end

[Severity level: Debug -Verbose]

- When a route is compressed or uncompressed.

[Severity level: Debug -Verbose]

Exceptional Scenarios. This section explains instances of exceptional route compression behavior.

- When a node does not have any best route.

Consider the routing table shown in [Table 129](#). When a node does not have any best route, children are uncompressed, if they were already compressed. Also this node is uncompressed, if it had previously been compressed.

Table 118: Route Manager's Table When There is No Best Route for a Node

Prefix	Gateway	Number of best paths	Compressed?
192.0.0.0/8	10.203.174.68	1	No
192.168.0.0/16	10.203.174.68	0	No
192.168.224.0/24	10.203.174.68	1	No
192.168.225.0/24	10.203.174.68	1	No

- When a node contains only a multicast route.

Route compression is applied to unicast routes only. If a node contains only a multicast route, the compression algorithm is not applied to the node. Therefore multicast nodes are considered as nodes with no best unicast routes as shown in [Table 130](#).

Table 119: Route Manager's Table When a Node Contains Only a Multicast Route

Prefix	Gateway	Unicast/Multicast	Compressed?
192.0.0.0/8	10.203.174.68	Unicast Route	No
192.168.0.0/16	10.203.174.68	Multicast Route	No
192.168.224.0/24	10.203.174.68	Unicast Route	No
192.168.225.0/24	10.203.174.68	Unicast Route	No

ECMP Handling When IP Route Sharing Is Enabled. The nodes that have ECMP table entries are compressed only if the following conditions are met; otherwise, potential sub-optimal forwarding occurs:

- The number of ECMP gateways for a given node must match the number of ECMP gateways in its parent node.
- A given node's set of gateways must match its parent's set of gateways.

Table 131 shows how compression is applied for the nodes with ECMP table entries when IP route sharing is enabled. Sample routes with ECMP table entries are taken for illustration. The Reason field in the table provides information about why the compression is applied or not applied for the node.

Table 120: Route Manager's Table When IP Route Sharing is Enabled

Prefix	Gateways	Compressed?	Reason
20.0.0.0/8	Gw1: 30.1.10.1, Gw2: 50.1.10.1	NO	This is the top node.
20.1.10.0/24	Gw1: 30.1.10.1	NO	Number of gateways did not match. This node has only one gateway, while the parent node has two.
20.2.10.0/24	Gw1: 30.1.10.1, Gw2: 60.1.10.1	NO	Number of gateways match. But one of the ECMP paths (gateway 60.1.10.1) does not match with its parent's ECMP paths.
20.3.10.0/24	Gw1: 30.1.10.1, Gw2: 50.1.10.1	YES	Number of gateways matches with its parent. Also all the gateways match with parent.
20.4.10.0/24	Gw1: 30.1.10.1, Gw2: 50.1.10.1 Gw3: 60.1.10.1	NO	Number of gateways does not match with its parent.
20.1.10.44/32	Gw1: 30.1.10.1 Gw2: 50.1.10.1	NO	Number of gateways did not match. [This node has ECMP table entries, but parent node 20.1.10.0 does not have an ECMP table entry.]

Table 132 shows only uncompressed routes.

Table 121: HAL(TCAM)/Kernel Routing Table When IP Route Sharing is Enabled

Prefix	Gateway
20.0.0.8/16	Gw1: 30.1.10.1, Gw2: 50.1.10.1
20.1.10.0/24	Gw1: 30.1.10.1
20.2.10.0/24	Gw1: 30.1.10.1, Gw2: 60.1.10.1

Table 121: HAL(TCAM)/Kernel Routing Table When IP Route Sharing is Enabled (Continued)

Prefix	Gateway
20.4.10.0/24	Gw1: 30.1.10.1, Gw2: 50.1.10.1 Gw3: 60.1.10.1
20.1.10.44/32	Gw1: 30.1.10.1 Gw2: 50.1.10.1

Sample output is shown below:

```
* (debug) BD-12804.9 # enable iproute sharing
* (debug) BD-12804.10 # show iproute
Ori Destination      Gateway      Mtr  Flags      VLAN      Duration
#s  Default Route    12.1.10.10  1    UG---S-um--f v1      0d:20h:1m:3s
#s  Default Route    12.1.10.12  1    UG---S-um--f v1      0d:19h:14m:58s
#d  12.1.10.0/24     12.1.10.62  1    U-----um--f v1      0d:20h:1m:3s
   d  16.1.10.0/24     16.1.10.62  1    -----um--- v16     0d:20h:1m:4s
#d  22.1.10.0/24     22.1.10.62  1    U-----um--f v2      0d:20h:1m:4s
#s  33.33.33.0/24    12.1.10.25  1    UG---S-um--f v1      0d:20h:1m:3s
#s  55.0.0.0/8       12.1.10.10  1    UG---S-um--f v1      0d:20h:1m:3s
#s  55.0.0.0/8       22.1.10.33  1    UG---S-um--f v2      0d:20h:1m:3s
#s  55.2.1.1/32      12.1.10.22  1    UG---S-um--f v1      0d:20h:1m:3s
#s  55.5.5.1/32      12.1.10.44  1    UG---S-um--f v1      0d:20h:1m:3s
#s  66.0.0.0/8       12.1.10.12  1    UG---S-um--f v1      0d:20h:1m:3s
#s  66.0.0.0/16      12.1.10.12  1    UG---S-um--c v1      0d:20h:1m:3s
#d  70.1.10.0/24     70.1.10.62  1    U-----um--f v7      0d:20h:1m:4s
#s  78.0.0.0/8       12.1.10.10  1    UG---S-um--f v1      0d:20h:1m:3s
#s  79.0.0.0/8       12.1.10.10  1    UG---S-um--c v1      0d:20h:1m:3s
#s  79.0.0.0/8       12.1.10.12  1    UG---S-um--c v1      0d:20h:1m:3s
#s  80.0.0.0/8       12.1.10.10  1    UG---S-um--f v1      0d:20h:1m:3s
#d  80.1.10.0/24     80.1.10.62  1    U-----um--f v8      0d:20h:1m:4s
#s  81.0.0.0/8       12.1.10.10  1    UG---S-um--f v1      0d:20h:1m:3s
#s  81.0.0.0/8       12.1.10.12  1    UG---S-um--f v1      0d:20h:1m:3s
#s  81.0.0.0/8       12.1.10.13  1    UG---S-um--f v1      0d:20h:1m:3s
#s  82.0.0.0/8       12.1.10.10  1    UG---S-um--f v1      0d:20h:1m:3s
#s  83.0.0.0/8       12.1.10.10  1    UG---S-um--f v1      0d:20h:1m:3s
#d  91.1.10.0/24     91.1.10.62  1    U-----um--f v9      0d:20h:1m:4s
#d  92.1.10.0/24     92.1.10.62  1    U-----um--f v10     0d:20h:1m:6s
#d  93.1.10.0/24     93.1.10.62  1    U-----um--f v11     0d:20h:1m:6s
```

```
Origin(Ori): (b) BlackHole, (be) EBGp, (bg) BGP, (bi) IBGP, (bo) BOOTP
              (ct) CBT, (d) Direct, (df) DownIF, (dv) DVMRP, (e1) ISISL1Ext
              (e2) ISISL2Ext, (h) Hardcoded, (i) ICMP, (i1) ISISL1 (i2) ISISL2
              (is) ISIS, (mb) MBGP, (mbe) MBGPExt, (mbi) MBGPInter, (mp) MPLS Lsp
              (mo) MOSPF (o) OSPF, (o1) OSPFExt1, (o2) OSPFExt2
              (oa) OSPFIntra, (oe) OSPFAsExt, (or) OSPFInter, (pd) PIM-DM, (ps) PIM-SM
              (r) RIP, (ra) RtAdvrt, (s) Static, (sv) SLB_VIP, (un) UnKnown
              (*) Preferred unicast route (@) Preferred multicast route
              (#) Preferred unicast and multicast route
```

```
Flags: (B) BlackHole, (D) Dynamic, (G) Gateway, (H) Host Route
        (L) Matching LDP LSP, (l) Calculated LDP LSP, (m) Multicast
        (P) LPM-routing, (R) Modified, (S) Static, (s) Static LSP
        (T) Matching RSVP-TE LSP, (t) Calculated RSVP-TE LSP, (u) Unicast, (U) Up
        (f) Provided to FIB (c) Compressed Route
```

Mask distribution:

```

2 default routes          12 routes at length 8
1 routes at length 16    9 routes at length 24
2 routes at length 32

```

Route Origin distribution:

```

8 routes from Direct      18 routes from Static

```

Total number of routes = 26

Total number of compressed routes = 3

ECMP Handling When IP Route Sharing Is Disabled. If IP route sharing is disabled, the first best route is installed in the hardware table, if multiple best routes are available. Hence the compression algorithm considers the first best route for ECMP cases. As shown in the Route Manager Table in [Table 133](#), when IP route sharing is disabled, all routes are compressed, except the first one in this case.

Table 122: Route Manager's Table When IP Route Sharing is Disabled

Prefix	Gateways	Compressed?
20.0.0.0/8	Gw1: 30.1.10.1, Gw2: 50.1.10.1	NO
20.1.10.0/24	Gw1: 30.1.10.1	YES
20.2.10.0/24	Gw1: 30.1.10.1, Gw2: 60.1.10.1	YES
20.3.10.0/24	Gw1: 30.1.10.1, Gw2: 50.1.10.1	YES
20.4.10.0/24	Gw1: 30.1.10.1, Gw2: 50.1.10.1 Gw3: 60.1.10.1	YES
20.1.10.44/32	Gw1: 30.1.10.1 Gw2: 50.1.10.1	YES

Table 123: HAL(TCAM)/Kernel Routing Table When IP Route Sharing is Disabled

Prefix	Gateway
20.0.0.8/16	Gw1: 30.1.10.1,

Sample output is shown below:

```

* (debug) BD-12804.7 # disable iproute sharing
* (debug) BD-12804.8 # show iproute
Ori Destination      Gateway           Mtr  Flags          VLAN      Duration
#s Default Route     12.1.10.10       1    UG---S-um--f  v1        0d:19h:58m:58s
#s Default Route     12.1.10.12       1    UG---S-um---  v1        0d:19h:12m:53s
#d 12.1.10.0/24      12.1.10.62       1    U-----um--f  v1        0d:19h:58m:59s
  d 16.1.10.0/24      16.1.10.62       1    -----um---  v16       0d:19h:58m:59s
#d 22.1.10.0/24      22.1.10.62       1    U-----um--f  v2        0d:19h:58m:59s
#s 33.33.33.0/24     12.1.10.25       1    UG---S-um--f  v1        0d:19h:58m:58s
#s 55.0.0.0/8        12.1.10.10       1    UG---S-um--c  v1        0d:19h:58m:58s
#s 55.0.0.0/8        22.1.10.33       1    UG---S-um---  v2        0d:19h:58m:58s
#s 55.2.1.1/32       12.1.10.22       1    UG---S-um--f  v1        0d:19h:58m:58s
#s 55.5.5.1/32       12.1.10.44       1    UG---S-um--f  v1        0d:19h:58m:58s
#s 66.0.0.0/8        12.1.10.12       1    UG---S-um--f  v1        0d:19h:58m:58s

```

```

#s 66.0.0.0/16      12.1.10.12      1    UG---S-um--c v1      0d:19h:58m:58s
#d 70.1.10.0/24    70.1.10.62      1    U-----um--f v7      0d:19h:58m:59s
#s 78.0.0.0/8      12.1.10.10      1    UG---S-um--c v1      0d:19h:58m:58s
#s 79.0.0.0/8      12.1.10.10      1    UG---S-um--c v1      0d:19h:58m:58s
#s 79.0.0.0/8      12.1.10.12      1    UG---S-um--- v1      0d:19h:58m:58s
#s 80.0.0.0/8      12.1.10.10      1    UG---S-um--c v1      0d:19h:58m:58s
#d 80.1.10.0/24    80.1.10.62      1    U-----um--f v8      0d:19h:58m:59s
#s 81.0.0.0/8      12.1.10.10      1    UG---S-um--c v1      0d:19h:58m:58s
#s 81.0.0.0/8      12.1.10.12      1    UG---S-um--- v1      0d:19h:58m:58s
#s 81.0.0.0/8      12.1.10.13      1    UG---S-um--- v1      0d:19h:58m:58s
#s 82.0.0.0/8      12.1.10.10      1    UG---S-um--c v1      0d:19h:58m:58s
#s 83.0.0.0/8      12.1.10.10      1    UG---S-um--c v1      0d:19h:58m:58s
#d 91.1.10.0/24    91.1.10.62      1    U-----um--f v9      0d:19h:58m:59s
#d 92.1.10.0/24    92.1.10.62      1    U-----um--f v10     0d:19h:59m:2s
#d 93.1.10.0/24    93.1.10.62      1    U-----um--f v11     0d:19h:59m:2s

```

Origin(Ori): (b) BlackHole, (be) EBGp, (bg) BGP, (bi) IBGP, (bo) BOOTP
(ct) CBT, (d) Direct, (df) DownIF, (dv) DVMRP, (e1) ISISL1Ext
(e2) ISISL2Ext, (h) Hardcoded, (i) ICMP, (i1) ISISL1 (i2) ISISL2
(is) ISIS, (mb) MBGP, (mbe) MBGPExt, (mbi) MBGPInter, (mp) MPLS Lsp
(mo) MOSPF (o) OSPF, (o1) OSPFExt1, (o2) OSPFExt2
(oa) OSPFIntra, (oe) OSPFAsExt, (or) OSPFInter, (pd) PIM-DM, (ps) PIM-SM
(r) RIP, (ra) RtAdvrt, (s) Static, (sv) SLB_VIP, (un) UnKnown
(*) Preferred unicast route (@) Preferred multicast route
(#) Preferred unicast and multicast route

Flags: (B) BlackHole, (D) Dynamic, (G) Gateway, (H) Host Route
(L) Matching LDP LSP, (l) Calculated LDP LSP, (m) Multicast
(P) LPM-routing, (R) Modified, (S) Static, (s) Static LSP
(T) Matching RSVP-TE LSP, (t) Calculated RSVP-TE LSP, (u) Unicast, (U) Up
(f) Provided to FIB (c) Compressed Route

Mask distribution:

```

2 default routes          12 routes at length 8
1 routes at length 16     9 routes at length 24
2 routes at length 32

```

Route Origin distribution:

```

8 routes from Direct      18 routes from Static

```

Total number of routes = 26

Total number of compressed routes = 8

LSP Route Handling. An LSP route is compressed only in the following circumstances:

- If the parent node of the LSP route is also an LSP route
- If the LSP nexthop of the parent node matches with this node

Hardware Routing Table Management

The switch hardware can route traffic based on information stored in hardware and software routing tables. Routing tasks are completed much faster when the routes are already stored in hardware routing tables. When packets are routed using the hardware routing tables, this is called *fast-path* routing, because the packets take the *fast path* through the switch.

The switch hardware provides the fast path, and the ExtremeXOS software provides the routing management capabilities, including management of the hardware routing tables. The software collects all routing information, manages the routes according to the switch configuration, and stores the appropriate routes in the hardware routing tables. When an IP unicast packet arrives and the destination IP address is not found in the hardware route tables, it is routed by software. The software processing takes more time than the fast path, so routing based on the software tables is called *slow-path* routing.

BlackDiamond X8 and 8000 series modules, SummitStack, and Summit X250e, X440, X450a, X450e, X460, X480, X650, and X670 switches allow you to customize the software management of the hardware routing tables using the following hardware components:

- [Extended IPv4 Host Cache on page 1263](#)
- [ECMP Hardware Table on page 1269](#)

Extended IPv4 Host Cache

The extended IPv4 host cache feature provides additional, configurable storage space on select switches to store additional IPv4 hosts in the hardware routing tables. This feature is supported on BlackDiamond X8 and 8000 series modules, SummitStack, and Summit X250e, X440, X450a, X450e, X460, X480, X650, and X670 switches. Some switches do not support this feature because they have more than enough storage space for IPv4 hosts, and some do not have the hardware required to support this feature.

All switches, except those with the L2 Edge license, support slow-path routing (using software routing tables), so adding more entries in the hardware routing table is a performance feature, which allows more hosts to benefit from fast-path routing. To use the extended IPv4 host cache feature effectively, it helps to understand how the hardware tables operate on the switches that support this feature. The hardware forwarding tables controlled by this feature store entries for the following:

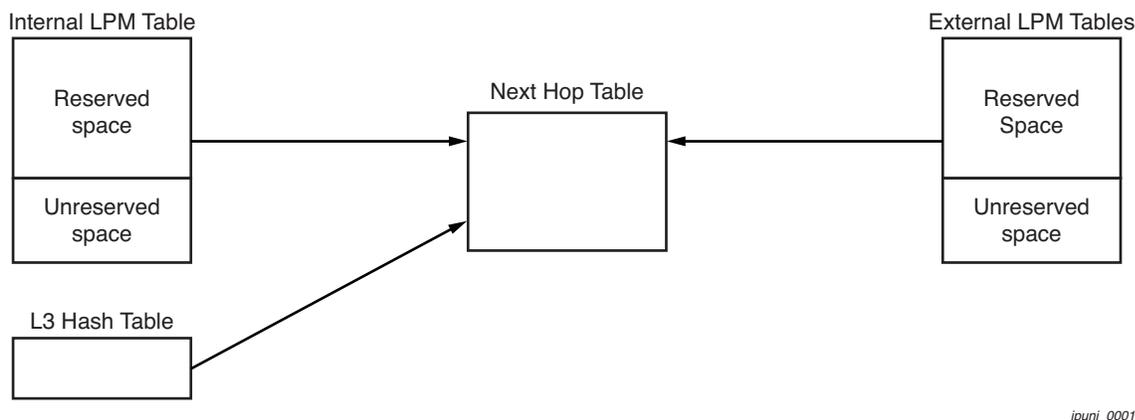
- IPv4 local and remote hosts
- IPv4 routes
- IPv6 local hosts
- IPv6 routes
- IPv4 multicast groups

The extended IPv4 host cache feature works by customizing the forwarding table space allotted to these components.

The following sections provide more information about the Extended IPv4 Host Cache feature:

- [Introduction to Hardware Forwarding Tables on page 1264](#)
- [LPM Table Management on page 1264](#)
- [Extended IPv4 Host Cache Management Guidelines on page 1267](#)
- [IPv4 Host Entry Population Sequence on page 1268](#)
- [Calculating the Number of Routes Needed on page 1269](#)
- [Coexistence of Higher- and Lower-Capacity Hardware on page 1269](#)

Introduction to Hardware Forwarding Tables. The extended IPv4 host cache feature relates to the four hardware forwarding tables shown in [Figure 194](#).

Figure 194: Hardware Forwarding Tables

The Longest Prefix Match (LPM) and Layer 3 (L3) Hash tables store host and route information for fast-path forwarding. When the switch locates a route or host in one of these tables, it follows a table index to the Next Hop table, which contains MAC address and egress port information that is shared by the hosts and routes in the other tables. The hardware routing table capacity is partly determined by the capacity of the Next Hop table. The Next Hop table capacity is smaller than the combined capacity of the other tables because typically, multiple routes and hosts share each Next Hop table entry. When the other tables map to many different next hop entries, the Next Hop table can limit the total number of hosts and routes stored in hardware.

On most platforms, the L3 Hash table is smaller than the LPM tables. Because the L3 Hash table is the only table that can store IPv4 multicast entries and IPv6 local hosts, and because of the way the L3 Hash table is populated, forwarding table capacity and forwarding performance can be improved by allocating space for storing IPv4 local and remote host entries in the LPM tables.

The extended IPv4 host cache feature specifically allows you to define the number of entries that are reserved in the LPM tables for IPv4 and IPv6 routes. The unreserved entries are available for IPv4 local and remote hosts. IPv4 hosts can also occupy unused areas of the L3 Hash table, and when necessary, unused space in the reserved section of the LPM tables. The maximum number of hosts that can be stored in the hardware routing tables depends on the configuration and usage of the tables, but the number of local IPv4 hosts and gateways is ultimately limited to the size of the Next Hop table minus three reserved entries.

LPM Table Management. The internal LPM tables are provided on all platforms. The external LPM tables are available only on BlackDiamond 8900 xl-series modules and Summit X480 switches, and they are supported only when external tables on those switches are configured to support external Layer 3 LPM entries. Because the external tables can be configured to support Layer 2 FDB entries, Layer 3 LPM entries, or ACL entries (or a combination of these), you must be aware of the external table configuration when managing LPM entries.

The ExtremeXOS software manages the content of the hardware tables based on the configuration specified by the following commands:

```
configure iproute reserved-entries [ <num_routes_needed> | maximum | default ] slot
[all | <slot_num>]
```

```
configure forwarding external-tables [l3-only {ipv4 | ipv4-and-ipv6 | ipv6} | l2-only
| acl-only | l2-and-l3 | l2-and-l3-and-acl | l2-and-l3-and-ipmc | none]
```

The `configure iproute reserved-entries` command configures the LPM tables. The `configure forwarding external-tables` command is available only on BlackDiamond 8900 xl-series modules and Summit X480 switches, and configures the use of the external tables.

IPv6 Routes and Hosts in External Tables. ExtremeXOS allows you to store IPv6 routes and hosts in external LPM tables. You can configure the external LPM to contain IPv4 or IPv6 routes, or both. Internal LPM tables can store IPv4 or IPv6 routes, both, or neither, based on the configuration setting for `external-tables`.

The `configure forwarding external-tables l3-only` command using the `ipv6` and `ipv4-and-ipv6` variables supports larger IPv6 route and host scaling in external LPM tables.

When an external LPM table is configured for `l3-only ipv6`, no IPv6 routes or IPv6 hosts are stored in any of the internal hardware tables. This provides the highest IPv6 scale, and avoids contention with IP Multicast in the L3 Hash hardware table.

IPv6 hardware and slowpath forwarding are supported on user-created Virtual Routers, and IPv6 tunnels are only supported on VR-Default.

The size of the internal LPM tables (as shown in [Table 137](#)), and the size of the L3 Hash and Next Hop tables are fixed. [Table 135](#) and [Table 136](#) list the hardware capacity for each of the tables shown in [Figure 208](#).

Table 124: Hardware Routing Table Configuration Capacities, Platforms without External Tables

Table	BlackDiamond 8900 xm-Series Modules and Summit X670 Switches	BlackDiamond 8000 a- and c-Series Modules and Summit X450a and X650 Switches	BlackDiamond 8000 e-Series Modules and Summit X250e and X450e Switches	BlackDiamond X8 Series Switches	Summit X440 Switches	Summit X460 Switches
Internal LPM	16384	12256	512	16384	64	12256
External LPM	N/A	N/A	N/A	N/A	N/A	N/A
L3 Hash	8192	8192	2048	16384	512	16384
Next Hop	8192	8192	2048	16384	512	16384

Table 125: Hardware Routing Table Configuration Capacities, Platforms with External Tables

Table	BlackDiamond 8900 xl-Series Modules and Summit X480 Switches ^a					
	I2-only, acl-only, and none Options	I2-and-I3-and-acl and I2-and-I3-and-ipmc Options	I2-and-I3 Option	I3-only Option	I3-only ipv4-and-ipv6 Option	I3-only ipv6 Option
Internal LPM IPv4	16352	N/A	N/A	N/A	N/A	16352 ^c
Internal LPM IPv6	8176	8192 ^b	8192 ^b	8192 ^b	N/A	N/A

Table 125: Hardware Routing Table Configuration Capacities, Platforms with External Tables

Table	BlackDiamond 8900 xl-Series Modules and Summit X480 Switches ^a					
	I2-only, acl-only, and none Options	I2-and-I3-and-acl and I2-and-I3-and-ipmc Options	I2-and-I3 Option	I3-only Option	I3-only ipv4-and-ipv6 Option	I3-only ipv6 Option
External LPM IPv4	N/A	131040	262112	524256	475104	N/A
External LPM IPv6	N/A	N/A	N/A	N/A	49152	245760
L3 Hash	16384	16384	16384	16384	16384	16384
Next Hop	16384	16384	16384	16384	16384	16384

- a. These platforms use additional external LPM tables and the actual value depends on the configuration set with the `configure forwarding external-tables` command.
- b. In this configuration, the internal LPM table stores only IPv6 routes. All IPv4 routes are stored in the external LPM tables.
- c. In this configuration, the internal LPM table stores only IPv4 routes. All IPv6 routes are stored in the external LPM tables.

In addition to configuring the number of reserved entries in the LPM tables, the `configure iproute reserved-entries` command configures which entries are stored in which tables. [Table 137](#) shows the hardware routing table contents for several configurations.

Table 126: Hardware Routing Table Contents

Table	BlackDiamond X8 Series and 8000 c-, e-, and xm-Series Modules. Summit X250e, X440, X450a, X450e, X460, X650, and X670 Switches	BlackDiamond 8900 xl-Series Modules and Summit X480 Switches, Maximum IPv4 Capacity Configuration	BlackDiamond 8900 xl-Series Modules and Summit X480 Switches, Maximum IPv6 Capacity Configuration	BlackDiamond 8900 xl-Series Modules and Summit X480 Switches, Default Configuration
Internal LPM—Reserved space	Entries for IPv4 and IPv6 routes.	Entries for IPv6 routes. ^a	Entries for IPv4 routes.	Entries for IPv6 routes. ^a
Internal LPM—Unreserved space	Entries for IPv4 local and remote hosts.	N/A ^b	Entries for IPv4 local and remote hosts.	N/A ^b
External LPM—Reserved space	N/A	Entries for IPv4 routes.	N/A	Entries for IPv4 routes.
External LPM—Unreserved space	N/A	Entries for IPv4 local and remote hosts.	Entries for IPv6 routes.	Entries for IPv4 local and remote hosts.

Table 126: Hardware Routing Table Contents (Continued)

Table	BlackDiamond X8 Series and 8000 c-, e-, and xm-Series Modules. Summit X250e, X440, X450a, X450e, X460, X650, and X670 Switches	BlackDiamond 8900 xl-Series Modules and Summit X480 Switches, Maximum IPv4 Capacity Configuration	BlackDiamond 8900 xl-Series Modules and Summit X480 Switches, Maximum IPv6 Capacity Configuration	BlackDiamond 8900 xl-Series Modules and Summit X480 Switches, Default Configuration
L3 Hash	Entries for IPv4 local and remote hosts, IPv4 multicast entries, and IPv6 local hosts. ^a	Entries for IPv4 local and remote hosts, IPv4 multicast entries, and IPv6 local hosts. ^a	Entries for IPv4 local and remote hosts, and IPv4 multicast entries.	IPv4 multicast entries, and IPv6 local hosts. ^a
Next Hop	MAC address and egress port information for the entries in the LPM and L3 Hash tables.	MAC address and egress port information for the entries in the LPM and L3 Hash tables.	MAC address and egress port information for the entries in the LPM and L3 Hash tables.	MAC address and egress port information for the entries in the LPM and L3 Hash tables.

a. IPv6 routes and hosts consume two entries.

b. In this configuration, all space in the internal LPM table is reserved for IPv6 routes.

Extended IPv4 Host Cache Management Guidelines. When configuring the extended IPv4 host cache feature, consider the following guidelines:

- The `default` option configures the switch to store entries for local and remote IPv4 hosts in the LPM tables. On BlackDiamond 8000 a-, c-, and, e--series modules and Summit X250e, X440, X450a, X450e, and X460 switches, the default setting creates room for 48 local and remote IPv4 host entries. On BlackDiamond 8900 xl-series modules and Summit X480 switches, the default setting creates room for 16384 local and remote IPv4 host entries. This option provides more room for IPv4 multicast and IPv6 hosts in the L3 Hash table.
- The `maximum` option reserves all space in the LPM tables for IPv4 and IPv6 routes. This option provides the maximum storage for IPv4 and IPv6 routes when you do not expect to store many IPv4 multicast and IPv6 hosts in the L3 Hash table.
- On BlackDiamond 8900 xl-series modules and Summit X480 switches, the `default` and `maximum` options automatically select a configuration that is compatible with the configuration defined by the `configure forwarding external-tables` command.
- On BlackDiamond 8900 xl-series modules and Summit X480 switches, the number you specify for the `num_routes_needed` must be compatible with the configuration defined by the `configure forwarding external-tables` command. If you specify a number that is greater than the number of routes specified by the current configuration, an error message appears.

**NOTE**

If no IPv4 route is found in the LPM table and IPv4 unicast packets are slow-path forwarded for a given remote host, an IPv4 entry is created for the remote host in either the L3 hash table or LPM table. The hardware does not cache entries for remote IPv6 hosts, so IPv6 routes take precedence over IPv4 routes when both IPv4 and IPv6 routes are stored in the Internal LPM table.

IPv4 Host Entry Population Sequence. The ExtremeXOS software populates the hardware tables with IPv4 host entries by searching for available space in the following sequence:

- 1 Unreserved space in the LPM tables as shown in [Table 137](#).
- 2 Available space in an L3 Hash table bucket.

- 3 Available space in the reserved section of the LPM table as shown in [Table 137](#).
- 4 Space used by the oldest host entries in the LPM and L3 Hash tables.

The L3 Hash table is named for the hash function, which stores host and multicast entries based on an algorithm applied to the host IP address or multicast tuple (Source IP, Group IP, VLAN ID). The hash table stores entries in groups of 8 or 16 (depending on the hardware), and these groups are called buckets. When a bucket is full, any additional host or multicast addresses that map or hash to that bucket cannot be added. Another benefit of the extended IPv4 host cache feature is that you can reduce these conflicts (or “hash table collisions”), by making room for IPv4 hosts in the LPM table and reducing demand for the L3 Hash table.

A hardware-based aging mechanism is used to remove any remote IPv4 host entries that have not had IPv4 unicast packets forwarded to them in the previous hour. (Note that remote IPv4 hosts only need to be cached when all IPv4 routes do not fit within the number of routes reserved.) Aging helps to preserve resources for the hosts that are needed most. In a BlackDiamond 8800 chassis or SummitStack, aging is performed independently for each I/O module or stack node based on the ingress traffic for that module or node. Depending on the IPv4 unicast traffic flows, independent IPv4 host caches for each I/O module or stack node can provide increased hardware fast-path forwarding compared with ExtremeXOS releases prior to 12.1. Even with aging, it is still possible that the Next Hop table, LPM table, or L3 Hash bucket do not have space to accept a new host. In those cases, a least-recently used algorithm is used to remove the oldest host to make space for the new host in hardware.

Local IPv4 host entries are only subject to hardware-based aging if there has been a large amount of least-recently used replacement, indicating severe contention for HW table resources. Otherwise, local IPv4 host entries are retained just as in ExtremeXOS releases prior to 12.1, based on whether IP ARP refresh is enabled or disabled, and the value for the `configure iparp timeout` command.



NOTE

Gateway entries are entries that represent routers or tunnel endpoints used to reach remote hosts. Gateway entries are not aged and are not replaced by IPv6 hosts or multicast entries in the L3 Hash table or by any entries requiring space in the Next Hop table. The software can move gateway entries from the LPM table to the L3 Hash table to make room for new reserved routes.

Calculating the Number of Routes Needed. Guidelines for calculating the number of routes to reserve are provided in the *ExtremeXOS Command Reference* description for the following command:

```
configure iproute reserved-entries [ <num_routes_needed> | maximum | default ] slot
[all | <slot_num>]
```

Coexistence of Higher- and Lower-Capacity Hardware. The BlackDiamond 8900 xl-series modules and Summit X480 switches are considered *higher-capacity hardware* because they provide external LPM tables, additional memory, and greater processing power, which allows this hardware to support a large number of IP routes. In comparison, other BlackDiamond 8000 series modules and Summit family switches are considered *lower-capacity hardware*.

The ExtremeXOS software supports the coexistence of higher- and lower-capacity hardware in the same BlackDiamond 8800 chassis or Summit family switch stack. To allow for coexistence and increased hardware forwarding, when the number of IPv4 routes exceeds 25,000, the lower-capacity hardware automatically transitions from using LPM routing to forwarding of individual remote hosts, also known as IP Forwarding Database (IP FDB) mode. Higher-capacity hardware continues using LPM routing. Lower capacity hardware operating in IP FDB mode is indicated with a *d* flag in the output of `show iproute reserved-entries statistics` command, indicating that only *direct* routes are installed.

**NOTE**

If you require a large number of IPv6 routes, you should use only xl-series modules, or a Summit X480 standalone, or a SummitStack comprised only of the X480. SummitStacks, or a BD8800 containing a mix of high- and low-capability hardware (slots without External TCAM) does not support more than 100,000 IPv6 routes present.

ECMP Hardware Table

IP route sharing and the ECMP hardware table are introduced in “[IP Route Sharing and ECMP](#)” on [page 1257](#). The following sections provide guidelines for managing the ECMP hardware table:

- [ECMP Table Configuration Guidelines on page 1269](#)
- [Troubleshooting: ECMP Table-Full Messages on page 1271](#)

**NOTE**

Summit X440 series switches do not support ECMP.

ECMP Table Configuration Guidelines. The ECMP table contains gateway sets, and each gateway set defines the equal-cost gateways that lead to a destination subnet. When IP route sharing is enabled, subnet entries in the LPM table can be mapped to gateway set entries in the ECMP table, instead of to a single gateway within the LPM table.

**NOTE**

ExtremeXOS does not support configuration of the ECMP tables on Summit X440 series switches.

For improved ECMP scaling, each LPM table entry on the following platforms points to a gateway set entry in the ECMP table:

- BlackDiamond 8000 and X series modules
- Summit X250e, X450a, X450e, X460, X480, X650, and X670 series switches

Each gateway set entry for the platforms listed above is unique and appears only once in the ECMP table. Multiple LPM table entries can point to the same gateway set entry. This efficient use of the ECMP table creates more room in the ECMP table for additional gateway set entries. It also makes IP route sharing available to every entry in the LPM table.

The following command allows you to configure the maximum number of next-hop gateways for gateway sets in the ECMP table:

```
configure iproute sharing max-gateways <max_gateways>
```

Each gateway entry in a gateway set consumes ECMP table space. As the `max_gateways` value decreases, the ECMP table supports more gateway sets. If you configure the `max_gateways` value to 8, the switch supports route sharing through up to 8 gateways per subnet, but supports the smallest number of gateway sets. If you do not need to support up to 8 different gateways for any subnet, you can decrease the `max_gateways` value to support more gateway sets.

To determine which gateways might be added to the ECMP table, consider how many local gateways are connected to the switch and can be used for ECMP, and consider the `max_gateways` value. For

example, suppose that you have four ECMP gateway candidates connected to the switch (labeled A, B, C, and D for this example) and the `max_gateways` option is set to 4. For platforms that allow a gateway set entry to support multiple subnets, this configuration could result in up to 11 gateway sets in the ECMP table: ABCD, ABC, ABD, ACD, BCD, AB, AC, AD, BC, BD, and CD.

If there are 4 gateways and you set `max_gateways` to 4, you can use the choose mathematical function to calculate the total number of gateway set possibilities as follows:

$$(4 \text{ choose } 4) + (4 \text{ choose } 3) + (4 \text{ choose } 2) = 11$$

To calculate the number of gateway set possibilities for a given number of total gateways and a specific `max_gateways` value, use the choose function in the following formula:

$$(TGW \text{ choose } MGW) + (TGW \text{ choose } MGW-1) + \dots + (TGW \text{ choose } 2) = TGWsets$$

In the formula above, *TGW* represents the total local gateways, *MGW* represents the `max_gateways` value, and *TGWsets* represents the total gateway sets needed to support all possible shared paths.

To see if your platform supports the total gateway sets needed, do the following:

- Calculate the total ECMP gateway sets possible as described above.
- Compare your result to the *IP route sharing (total combinations of gateway sets)* capacities listed in the *ExtremeXOS Release Notes* to verify that the switch can support the desired number of gateway sets.

Troubleshooting: ECMP Table-Full Messages. If the ECMP table is full, no new gateway sets can be added, and IP forwarding is still done in hardware through one of the following:

- For platforms that allow a gateway set entry to support multiple subnets, forwarding can be done using an existing gateway set that is a partial subset of the unavailable gateway set. If the unavailable gateway set consists of *N* gateways, the subset used could include a range of gateways from *N-1* gateways down to a single gateway. For example, if the ECMP table does not have room for a new gateway set using gateways E, F, G, and H, a partial subset such as EFG, EF, or E will be used.
- For platforms that require one gateway set entry per subnet, forwarding is done through a single gateway.

On BlackDiamond 8000 and X series modules and Summit family switches, an ECMP table-full condition produces the following message:

```
<Info:Kern.IPv4FIB.Info> Slot-1: IPv4 route can not use sharing on all its gateways.
Hardware ECMP Table full. Packets are HW forwarded across a subset of gateways.
(Logged at most once per hour.)
```

If the ECMP table-full message appears, consider the following remedies:

- If the message source is a BlackDiamond 8000 e-series module or a Summit X250e or X450e switch, the ECMP table capacity is lower than for the following hardware: BlackDiamond X8 series and 8000 a-, c-, xl-, and xm-series hardware and Summit X450a, X460, X480, X650, and X670 series switches. Consider upgrading your hardware to support the greater ECMP table capacity. See the *ExtremeXOS Release Notes* for information on the *total combinations of gateway sets* supported for IP route sharing on different platforms.
- Reduce the number of gateways adjacent to the switch used for IP route sharing.
- Monitor the switch to see if the condition is transient. For example, if the number of ECMP table entries temporarily increases due to a network event and then returns to within the supported range, a permanent change might not be required.
- Determine if IP route sharing to all gateways is required. Since traffic is still being forwarded in hardware using one or more gateways, the condition may be acceptable.

Configuring Unicast Routing

This section describes the following tasks:

- [Configuring Basic Unicast Routing on page 1217](#)
- [Adding a Default Route or Gateway on page 1218](#)
- [Configuring Static Routes on page 1218](#)
- [Configuring the Relative Route Priority on page 1218](#)
- [Configuring Hardware Routing Table Usage on page 1218](#)
- [Configuring IP Route Sharing on page 1219](#)
- [Configuring Route Compression on page 1219](#)
- [Configuring Static Route Advertisement on page 1220](#)
- [Configuring Distributed IP ARP Mode on page 1220](#)

Configuring Basic Unicast Routing

To configure IP unicast routing on the switch:

- 1 Create and configure two or more VLANs.
- 2 For each VLAN that participates in IP routing, assign an IP address using the following command:

```
configure {vlan} <vlan_name> ipaddress [<ipaddress> {<ipNetmask>} | ipv6-link-
local | {eui64} <ipv6_address_mask>]
```

Ensure that each VLAN has a unique IP address.

- 3 Configure a default route using the following command:

```
configure iproute add default <gateway> {<metric>} {multicast | multicast-only |
unicast | unicast-only} {vr <vrname>}
```

Default routes are used when the router has no other dynamic or static route to the requested destination.

- 4 Turn on IP routing for one or all VLANs using the following command:

```
enable ipforwarding {ipv4 | broadcast | ignore-broadcast | fast-direct-broadcast}
{vlan <vlan_name>}
```

- 5 Configure the routing protocol, if required. For a simple network using RIP, the default configuration may be acceptable.

- 6 Turn on RIP or OSPF using one of the following commands:

```
enable rip
enable ospf
```



NOTE

Unicast reverse path forwarding is available to help prevent Distributed Denial of Service attacks. For complete information, see [“The protocol anomaly detection security functionality is supported by a set of anomaly-protection enable, disable, configure, clear, and show CLI commands. For further details, see Chapter 23, “Security Commands,” in the ExtremeXOS Command Reference Guide.” on page 914.](#)

Adding a Default Route or Gateway

A default route or gateway defines a default interface to which traffic is directed when no specific routes are available. To add a default route, use the command:

```
configure iproute add default <gateway> {<metric>} {multicast | multicast-only |
unicast | unicast-only} {vr <vrname>}
```



NOTE

If you define a default route and subsequently delete the VLAN on the subnet associated with the default route, the invalid default route entry remains. You must manually delete the configured default route.

Configuring Static Routes

To configure a static route, use the command:

```
configure iproute add [<ipNetmask> | <ip_addr> <mask>] <gateway> {bfd} {metric}
{multicast | multicast-only | unicast | unicast-only} {vr <vrname>}
```

A static route's nexthop (gateway) must be associated with a valid IP subnet and cannot use the same IP address as a local VLAN. An IP subnet is associated with a single VLAN by its IP address and subnet mask. If the VLAN is subsequently deleted, the static route entries using that subnet must be deleted manually.

This command can enable or disable BFD protection for one static route. However, this protection is not provided until the BFD client is enabled at each end of the route with the following command:

```
enable iproute bfd {gateway} <ip_addr> {vr <vrname>}
```

To disable BFD protection for a static route, use the following command:

```
disable iproute bfd {gateway} <ip_addr> {vr <vrname>}
```

Configuring the Relative Route Priority

To change the relative route priority, use the following command:

```
configure iproute {ipv4} priority [blackhole | bootp | ebgp | ibgp | icmp | isis |
isis-level-1 | isis-level-1-external | isis-level-2 | isis-level-2-external | mpls |
ospf-as-external | ospf-extern1 | ospf-extern2 | ospf-inter | ospf-intra | rip |
static] <priority> {vr <vrname>}
```

Configuring Hardware Routing Table Usage



NOTE

This procedure applies only to BlackDiamond X8 and 8000 series modules and Summit X250e, X440, X450a, X450e, X460, X480, X650, and X670 switches.

Allowing individual local and remote IPv4 unicast hosts to occupy the unused portion of the Longest Prefix Match (LPM) table helps reduce Layer 3 hardware hash table collisions, and reduces slowpath

forwarding of IP unicast and multicast traffic. For more information, see [“Hardware Routing Table Management” on page 1262](#).

To configure the number of IP routes to reserve in the LPM hardware table, use the command:

```
configure iproute reserved-entries [ <num_routes_needed> | maximum | default ] slot
[all | <slot_num>]
```

To display the current configuration for IP route reserved entries, use the command:

```
show iproute reserved-entries {slot <slot_num>}
```

To display the hardware table usage for IP routes, unicast and multicast, use the command:

```
show iproute reserved-entries statistics { slot <slot_num> }
```

Configuring IP Route Sharing

IP route sharing is introduced in [IP Route Sharing and ECMP](#). The following sections describe how to manage IP route sharing:

- [“Managing IP Route Sharing on BlackDiamond X8 and 8000 Series Modules, SummitStack, and Summit Family Switches” on page 1219](#)
- [“Viewing the IP Route Sharing Configuration” on page 1219](#)

Managing IP Route Sharing on BlackDiamond X8 and 8000 Series Modules, SummitStack, and Summit Family Switches

For BlackDiamond X8 and 8000 series modules, SummitStack, and Summit family switches that support Layer 3 routing, the ExtremeXOS software supports route sharing across up to 2, 4, or 8 next-hop gateways. To configure the maximum number of ECMP gateways, use the following command:

```
configure iproute sharing max-gateways <max_gateways>
```

For guidelines on managing the number of gateways, see [“ECMP Hardware Table” on page 1269](#).

To enable route sharing, use the command:

```
enable iproute {ipv4} sharing {{vr} <vrname>}
```

To disable route sharing, use the command:

```
disable iproute {ipv4} sharing {{vr} <vrname>}
```

Viewing the IP Route Sharing Configuration

To view the route sharing configuration, use the following command:

```
show ipconfig {ipv4} {vlan <vlan_name>}
```

Configuring Route Compression

To enable route compression for IPv4 routes, use the following command:

```
enable iproute compression {vr <vrname>}
```

To disable route compression for IPv4 routes, use the following command:

```
disable iproute compression {vr <vrname>}
```

When you enable or disable route compression, that process is performed in chunks, rather than as one single processing event. Because the ExtremeXOS Route Manager processes a limited number of IP prefixes per second, route compression should not have any significant impact on performance. Likewise, when IP route compression is enabled, incremental route addition or deletion should not have a significant impact on performance.

Configuring Static Route Advertisement

To enable or disable advertisement of all static routes, use one of the following commands:

- `enable rip export [bgp | direct | e-bgp | i-bgp | ospf | ospf-extern1 | ospf-extern2 | ospf-inter | ospf-intra | static | isis | isis-level-1 | isis-level-1-external | isis-level-2 | isis-level-2-external] [cost <number> {tag <number>} | policy <policy-name>]`
or
`disable rip export [bgp | direct | e-bgp | i-bgp | ospf | ospf-extern1 | ospf-extern2 | ospf-inter | ospf-intra | static | isis | isis-level-1 | isis-level-1-external | isis-level-2 | isis-level-2-external]`
- `enable ospf export [bgp | direct | e-bgp | i-bgp | rip | static | isis | isis-level-1 | isis-level-1-external | isis-level-2 | isis-level-2-external] [cost <cost> type [ase-type-1 | ase-type-2] {tag <number>} | <policy-map>]`
or
`disable ospf export [bgp | direct | e-bgp | i-bgp | rip | static | isis | isis-level-1 | isis-level-1-external | isis-level-2 | isis-level-2-external]`

Configuring Distributed IP ARP Mode

The distributed IP ARP feature is available only on BlackDiamond X8 and 8800 series switches. The distributed IP ARP feature provides higher IP ARP scaling by distributing IP ARP forwarding information to only the I/O module to which each IP host is connected. This feature is off by default to match the operation in ExtremeXOS releases prior to 12.5. When this feature is off, complete IP ARP information for all destinations is stored on all modules, reducing the available space for unique destinations.

To activate or deactivate the distributed IP ARP feature, use the following command:

```
configure iparp distributed-mode [on | off]
```



NOTE

The switch does not use the specified feature configuration until the next time the switch boots. If you are using load sharing, refer to the ExtremeXOS Command Reference command description for the above command for information on load sharing restrictions.

To display the configured and current states for this feature, use the following command:

```
show iparp {<ip_addr> | <mac> | vlan <vlan_name> | permanent} {vr <vr_name>}
```

To display distributed IP ARP mode statistics when this feature is enabled, use the following command:

```
show iparp distributed-mode statistics { slot [ <slot> | all ] }
```

Displaying the Routing Configuration and Statistics

The following sections describe ways to view the routing configuration:

- [Viewing IP Routes on page 1276](#)
- [Viewing the IP ARP Table on page 1276](#)
- [Viewing IP ARP Statistics on page 1276](#)
- [Viewing the IP Configuration for a VLAN on page 1276](#)
- [Viewing Compressed Routes on page 1276](#)

Viewing IP Routes

Use the `show iproute` command to display the current configuration of IP unicast routing for the switch and for each VLAN. The `show iproute` command displays the currently configured routes and includes how each route was learned.

Viewing the IP ARP Table

To view the IP ARP table entries and configuration, use the `show iparp` command.

Viewing IP ARP Statistics

To view IP ARP table statistics, use the following commands:

```
show iparp distributed-mode statistics { slot [ <slot> | all ] }
show iparp stats [[ <vr_name> | vr {all | <vr_name>} ] {no-refresh} | {vr} summary]
show iparp stats [vlan {all {vr <vr_name>}}] | {vlan} <vlan_name>] {no-refresh}
show iparp stats ports {all | <port_list>} {no-refresh}
```

Viewing the IP Configuration for a VLAN

To view the IP configuration for one or more VLANs, use the `show ipconfig` command.

Viewing Compressed Routes

View a compressed route using the following command:

```
show iproute
```

Sample output:

Ori	Destination	Gateway	Mtr	Flags	VLAN	Duration
#be	3.0.0.0/8	111.222.0.5	7	UG-D---um---	feed	0d:19h:52m:49s
#be	4.0.0.0/8	111.222.0.5	5	UG-D---um---	feed	0d:19h:52m:49s
#be	4.0.0.0/9	111.222.0.5	5	UG-D---um--c	feed	0d:19h:52m:49s
#be	4.23.84.0/22	111.222.0.5	7	UG-D---um--c	feed	0d:19h:52m:49s
#be	4.23.112.0/22	111.222.0.5	7	UG-D---um--c	feed	0d:19h:52m:49s

Origin(Ori): (b) BlackHole, (be) EBGp, (bg) BGP, (bi) IBGP, (bo) BOOTP
(ct) CBT, (d) Direct, (df) DownIF, (dv) DVMRP, (e1) ISISL1Ext
(e2) ISISL2Ext, (h) Hardcoded, (i) ICMP, (i1) ISISL1 (i2) ISISL2
(mb) MBGP, (mbe) MBGPExt, (mbi) MBGPInter
(mo) MOSPF (o) OSPF, (o1) OSPFExt1, (o2) OSPFExt2
(oa) OSPFIntra, (oe) OSPFAsExt, (or) OSPFInter, (pd) PIM-DM, (ps) PIM-SM
(r) RIP, (ra) RtAdvrt, (s) Static, (sv) SLB_VIP, (un) UnKnown
(*) Preferred unicast route (@) Preferred multicast route
(#) Preferred unicast and multicast route

Flags: (B) BlackHole, (D) Dynamic, (G) Gateway, (H) Host Route
(m) Multicast, (P) LPM-routing, (R) Modified, (S) Static
(u) Unicast, (U) Up (c) Compressed

Mask distribution:
19 routes at length 8 9 routes at length 9
9 routes at length 10 28 routes at length 11

Route Origin distribution:
7 routes from Direct 184816 routes from EBGp

Total number of routes = 184823
Total number of compressed routes = 93274

Display an iproute summary using the following command:

show iproute summary

Sample output:

```
=====ROUTE SUMMARY=====
Mask distribution:
    1 routes at length 8            7 routes at length 24
    1 routes at length 32

Route origin distribution:
6    Static            3    Direct
```

Total number of routes = 9
Total number of compressed routes = 4

Display a Route Manager configuration using the following command:

show configuration rtmgr

Sample output:

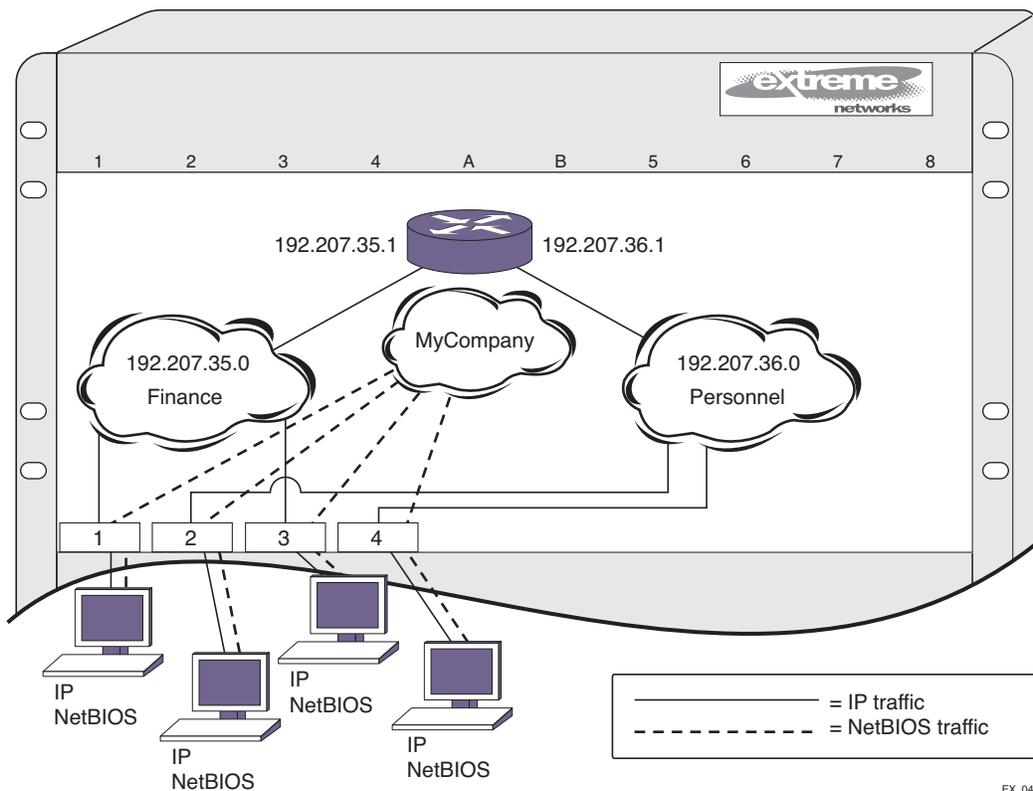
```
#
# Module rtmgr configuration.
#
disable iproute sharing
configure iproute priority mpls 20
.....
disable icmp timestamp vlan "to62"
enable ip-option loose-source-route
enable iproute compression ipv4 vr "VR-Default"
```

Routing Configuration Example

Figure 209 illustrates a BlackDiamond switch that has three VLANs defined as follows:

- *Finance*
 - All ports on slots 1 and 3 have been assigned.
 - IP address 192.207.35.1.
- *Personnel*
 - Protocol-sensitive VLAN using the IP protocol.
 - All ports on slots 2 and 4 have been assigned.
 - IP address 192.207.36.1.
- *MyCompany*
 - Port-based VLAN.
 - All ports on slots 1 through 4 have been assigned.

Figure 195: Unicast Routing Configuration Example



The stations connected to the system generate a combination of IP traffic and NetBIOS traffic. The IP traffic is filtered by the protocol-sensitive VLANs. All other traffic is directed to the VLAN *MyCompany*.

In this configuration, all IP traffic from stations connected to slots 1 and 3 have access to the router by way of the VLAN *Finance*. Ports on slots 2 and 4 reach the router by way of the VLAN *Personnel*. All other traffic (NetBIOS) is part of the VLAN *MyCompany*.

The example in [Figure 209](#) is configured as follows:

```
create vlan Finance
create vlan Personnel
create vlan MyCompany

configure Finance protocol ip
configure Personnel protocol ip

configure Finance add port 1:*,3:*
configure Personnel add port 2:*,4:*
configure MyCompany add port all

configure Finance ipaddress 192.207.35.1
configure Personnel ipaddress 192.207.36.1
configure rip add vlan Finance
configure rip add vlan Personnel

enable ipforwarding
enable rip
```

Duplicate Address Detection

The Duplicate Address Detection (DAD) feature checks networks attached to a switch to see if IP addresses configured on the switch are already in use on an attached network. The following sections provide additional information on the DAD feature:

- [“DAD Overview” on page 1279](#)
- [“Guidelines and Limitations” on page 1281](#)
- [“Configuring DAD” on page 1281](#)
- [“Running a DAD Check” on page 1282](#)
- [“Displaying DAD Configuration and Statistics” on page 1282](#)
- [“Clearing the DAD Counters” on page 1282](#)

DAD Overview

When enabled on a user VR or *VR-Default*, the DAD feature checks all IP addresses configured on the DAD-enabled VRs to determine if there are duplicate IP addresses on the networks connected to the switch. If a duplicate address is discovered, the switch does one of the following:

- Marks the IP address as *valid*
- Marks the IP address as *duplicate* and generates EMS events to advertise this

At the completion of the DAD check for each interface, the interface is marked valid or duplicate. A *valid* IP interface can be used by all switch processes for IP communications. There are no restrictions on a valid IP address. If no duplicate address is detected, the IP address is marked valid.

A *duplicate* IP address cannot be used for IP communications. If a duplicate IP address is detected, the marking depends on the action that initiated the test and can depend on a previous marking for the IP address. For some events, a duplicate IP address generates an EMS event, and for some other events, a duplicate IP address results in a disabled IP address and corresponding EMS events.

The following sections provide more information on the DAD feature and how it affects switch operation:

- [Prerequisites for a DAD Check on page 1280](#)
- [The DAD Check on page 1280](#)
- The DAD check is repeated a configurable number of times for each IP interface. During the IPv4 DAD check, the status for an interface under test is tentative, and this status is shown with the T flag when the `show ip dad` command is entered. The DAD check is very fast, so it might be hard to view the tentative state for an address. If the address had previously been marked duplicate, the status remains duplicate while the DAD check runs. If no duplicate address is detected when the DAD check runs at interface startup, the interface IP address is declared valid. [on page 1280](#)
- [Switch Impact for DAD State Changes on page 1281](#)
- [Fixing a Duplicate IP Address on page 1281](#)

Prerequisites for a DAD Check

To successfully test an IP interface, at least one port in the host VLAN must be in the *Up* state. If all ports in the host VLAN are *Down*, the DAD check does not run.

The DAD check does not run on loopback VLANs; an IP address for a loopback VLAN is marked valid and the address is identified in the `show ip dad` command display with the L flag.

The DAD Check

The DAD feature checks IP addresses by sending an ARP request to each IP address it checks. The source IP address in the ARP request is 0, and the destination IP address is the IP address being checked. If another device replies to the ARP request, a duplicate IP address is detected.

The DAD check is repeated a configurable number of times for each IP interface. During the IPv4 DAD check, the status for an interface under test is *tentative*, and this status is shown with the T flag when the `show ip dad` command is entered. The DAD check is very fast, so it might be hard to view the tentative state for an address. If the address had previously been marked *duplicate*, the status remains *duplicate* while the DAD check runs. If no duplicate address is detected when the DAD check runs at interface startup, the interface IP address is declared valid.

If the DAD check feature is not enabled at startup, you can enable it after startup with a CLI command. Once enabled at the switch prompt, a DAD check runs on all IP interfaces when you enter the `run ip dad`, and it automatically runs on a single interface when an interface is initialized.



NOTE

When you enable the DAD feature at the CLI prompt, no DAD check is performed until you enter the `run ip dad` command or an interface is initialized.

An interface initialization can be triggered by enabling a disabled VLAN that has an IP configuration, or you can initialize an interface by adding an IP address to a VLAN and enabling IP forwarding. The DAD check runs only on the interface being initialized, and it does not run again until another interface is initialized.

When a duplicate IP address is detected, an EMS event is generated and the IP address is marked as follows:

- **Valid**—The interface remains valid if it was marked valid as a result of a previous DAD check. This treatment prevents the switch from disabling an interface that was working and now has an address conflict with another device.
- **Duplicate**—The duplicate IP address is disabled and cannot be used by switch processes. This treatment is appropriate for an interface that is just joining a network and should not conflict with pre-established services.

You can use the `show ip dad` command to display duplicate IP addresses, which are marked with the *D* flag.

Switch Impact for DAD State Changes

When an IP address is in a duplicate or tentative state, the normal behavior of the switch may change since that IP address isn't usable, even though it does exist. The following are some examples of what can happen when an IP address is marked duplicate or tentative:

- Routes may be withdrawn or marked inactive
- Dynamic IP ARP entries may get flushed
- VRRP virtual router instances may be disabled and put into init state causing the backup VRRP router to take over mastership.
- Ping and traceroute commands may fail.
- The DHCP client will send a DHCP decline to the DHCP server if the IP address for a DHCP client on a VLAN is not Valid
- The DHCP scope IP address range configuration might fail when the DHCP enabled VLAN IP address becomes duplicate.
- SNMP requests may fail
- SNMP traps will not be sent if the if the configured source IP address is not Valid

Fixing a Duplicate IP Address

If a DAD check declares an IP address *duplicate*, the address remains *duplicate* until a later DAD check declares the IP address valid, or until the affected VLAN is configured as a loopback VLAN. To make the interface IP address valid, do either of the following:

- Correct the duplicate address situation and enter the `run ip dad` command.
- Disable the host VLAN, correct the duplicate address situation, and bring up the interface.

Guidelines and Limitations

The following guidelines and limitations apply to the DAD check feature:

- IPv6 and GRE tunnels are not supported on IP addresses that are validated by a DAD check.
- The DAD check does not run on loopback VLANs; an IP address for a loopback VLAN is marked valid and the address is identified in the `show ip dad` command display with the L flag.
- The switch MAC address is installed for a VLAN if needed.
- DAD detects duplicate IPv4 address configured on a VLAN that spans MLAG peer switches only when the solicitation attempts using "configure ip dad attempts <max_solicitations>" is more than 1.

Configuring DAD

To enable or disable the DAD feature and configure feature operation, use the following command:

```
configure ip dad [off | on | {on} attempts <max_solicitations>] {{vr} <vr_name> | vr all}
```

Running a DAD Check

To initiate a DAD check, use the following command:

```
run ip dad [{vlan} <vlan_name> | {{vr} <vr_name>} <ip_address>]
```

Displaying DAD Configuration and Statistics

To display DAD configuration and statistics information, use the following command:

```
show ip dad {{{vr} <vr_name> {<ip_address>} | vr all | {vlan} <vlan_name>}
```

Clearing the DAD Counters

To clear the DAD feature statistics counters, use the following command:

```
clear ip dad {{vr} <vr_name> {<ip_address>} | vr all | {vlan} <vlan_name>} {counters}
```

Proxy ARP

Proxy Address Resolution Protocol (ARP) was first invented so that ARP-capable devices could respond to ARP request packets on behalf of ARP-incapable devices. Proxy ARP can also be used to achieve router redundancy and to simplify IP client configuration. The switch supports proxy ARP for this type of network configuration. The following sections provide additional information on using proxy ARP with the switch:

- [ARP-Incapable Devices on page 1282](#)
- [Proxy ARP Between Subnets on page 1283](#)

ARP-Incapable Devices

To configure the switch to respond to ARP requests on behalf of devices that are incapable of doing so, you must configure the IP address and MAC address of the ARP-incapable device using the following command:

```
configure iparp add proxy [<ipNetmask> | <ip_addr> {<mask>}] {vr <vr_name>} {<mac> | vrrp} {always}
```

After it is configured, the system responds to ARP requests on behalf of the device as long as the following conditions are satisfied:

- The valid IP ARP request is received on a router interface.
- The target IP address matches the IP address configured in the proxy ARP table.
- The proxy ARP table entry indicates that the system should answer this ARP request, based on the ingress VLAN and whether the `always` parameter is set. When the `always` option is set, the switch

always responds to the ARP request even when the ARP requester is on the same subnet as the requested host. If the `always` option is not set, the switch only answers if the ARP request comes in from a VLAN that is not on the same subnet as the requested host.

When all the proxy ARP conditions are met, the switch formulates an ARP response using one of the following MAC addresses:

- A specific MAC address specified with the `<mac>` option
- The VRRP virtual MAC address when the `vrrp` option is specified and the request is received on a VLAN that is running VRRP.
- The switch MAC address when neither of the above options applies.

Proxy ARP Between Subnets

In some networks, it is desirable to configure the IP host with a wider subnet than the actual subnet mask of the segment. You can use proxy ARP so that the router answers ARP requests for devices outside of the subnet. As a result, the host communicates as if all devices are local. In reality, communication with devices outside of the subnet are proxied by the router.

For example, an IP host is configured with a class B address of 100.101.102.103 and a mask of 255.255.0.0. The switch is configured with the IP address 100.101.102.1 and a mask of 255.255.255.0. The switch is also configured with a proxy ARP entry of IP address 100.101.0.0 and mask 255.255.0.0, *without* the `always` parameter.

When the IP host tries to communicate with the host at address 100.101.45.67, the IP host communicates as if the two hosts are on the same subnet, and sends out an IP ARP request. The switch answers on behalf of the device at address 100.101.45.67, using its own MAC address. All subsequent data packets from 100.101.102.103 are sent to the switch, and the switch routes the packets to 100.101.45.67.

IPv4 Multinetting

IP multinetting refers to having multiple IP networks on the same bridging domain (or VLAN). The hosts connected to the same physical segment can belong to any one of the networks, so multiple subnets can overlap onto the same physical segment. Any routing between the hosts in different networks is done through the router interface. Typically, different IP networks are on different physical segments, but IP multinetting does not require this.

Multinetting can be a critical element in a transition strategy, allowing a legacy assignment of IP addresses to coexist with newly configured hosts. However, because of the additional constraints introduced in troubleshooting and bandwidth, Extreme Networks recommends that you use multinetting as a transitional tactic only, and not as a long-term network design strategy.

Multinetting was not supported in ExtremeXOS 10.1, but versions of ExtremeWare before that supported a multinetting implementation that required separate VLANs for each IP network. The implementation introduced in ExtremeXOS is simpler to configure, does not require that you create a dummy multinetting protocol, and does not require that you create VLANs for each IP network. This implementation does not require you to explicitly enable IP multinetting. Multinetting is automatically enabled when a secondary IP address is assigned to a VLAN.

The following sections discuss these multinetting topics:

- [Multinetting Topology on page 1284](#)
- [How Multinetting Affects Other Features on page 1284](#)
- [Configuring IPv4 Multinetting on page 1288](#)
- [IP Multinetting Examples on page 1289](#)

Multinetting Topology

For an IP multinetted interface, one of the IP networks on the interface acts as the transit network for the traffic that is routed by this interface. The transit network is the primary subnet for the interface. The remaining multinetted subnets, called the secondary subnets, must be stub networks. This restriction is required because it is not possible to associate the source of the incoming routed traffic to a particular network. IP routing happens between the different subnets of the same VLAN (one arm routing) and also between subnets of different VLANs.

Figure 196: Multinetted Network Topology

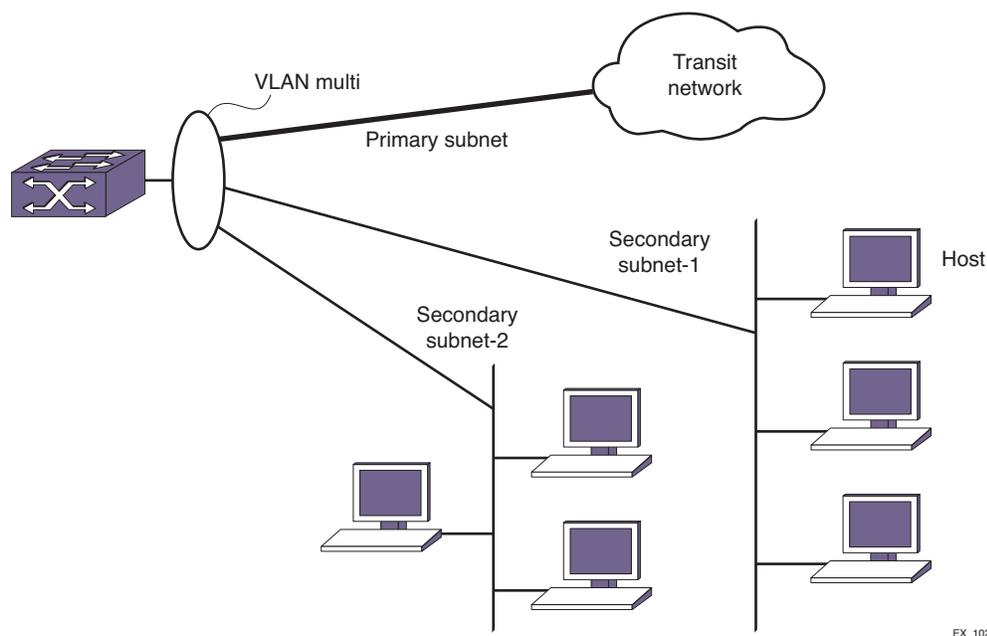


Figure 210 shows a multinetted VLAN named *multi*. VLAN *multi* has three IP subnets so three IP addresses have been configured for the VLAN. One of the subnets is the primary subnet and can be connected to any transit network (for example, the Internet). The remaining two subnets are stub networks, and multiple hosts such as management stations (such as user PCs and file servers) can be connected to them. You should not put any additional routing or switching devices in the secondary subnets to avoid routing loops. In Figure 210 the subnets are on separate physical segments, however, multinetting can also support hosts from different IP subnets on the same physical segment.

When multinetting is configured on a VLAN, the switch can be reached using any of the subnet addresses (primary or secondary) assigned to VLAN. This means that you can perform operations like ping, Telnet, Trivial File Transfer Protocol (TFTP), Secure Shell 2 (SSH2), and others to the switch from a host residing in either the primary or the secondary subnet of the VLAN. Other host functions (such as traceroute) are also supported on the secondary interface of a VLAN.

How Multinetting Affects Other Features

The following sections explain how multinetting affects both Layer 2 and Layer 3 ExtremeXOS features:

- [ARP on page 1285](#)
- [Route Manager on page 1285](#)
- [IRDP on page 1285](#)
- [Unicast Routing Protocols on page 1285](#)
- [IGMP Snooping and IGMP on page 1287](#)
- [Multicast Routing Protocols on page 1287](#)
- [EAPS, ESRP, and STP on page 1287](#)
- [DHCP Server on page 1287](#)
- [DHCP Relay on page 1287](#)
- [VRRP on page 1288](#)

ARP

ARP operates on the interface and responds to every request coming from either the primary or secondary subnet. When multiple subnets are configured on a VLAN and an ARP request is generated by the switch over that VLAN, the source IP address of the ARP request must be a local IP address of the subnet to which the destination IP address (which is being ARPed) belongs.

For example, if a switch multinets the subnets 10.0.0.0/24 and 20.0.0.0/24 (with VLAN IP addresses of 10.0.0.1 and 20.0.0.1), and generates an ARP request for the IP address 10.0.0.2, then the source IP address in the ARP packet is set to 10.0.0.1 and not to 20.0.0.1.

Route Manager

The Route Manager installs a route corresponding to each of the secondary interfaces. The route origin is direct, is treated as a regular IP route, and can be used for IP data traffic forwarding.

These routes can also be redistributed into the various routing protocol domains if you configure route redistribution.

IRDP

Some functional changes are required in Internet Router Discovery Protocol (IRDP) to support IP multinetting. When IRDP is enabled on a Layer 3 VLAN, the ExtremeXOS software periodically sends ICMP router advertisement messages through each subnet (primary and secondary) and responds to ICMP router solicitation messages based on the source IP address of the soliciting host.

Unicast Routing Protocols

Unicast routing protocols treat each IP network as an interface. The interface corresponding to the primary subnet is the active interface, and the interfaces corresponding to the secondary subnet are passive subnets.

For example, in the case of Open Shortest Path First (OSPF), the system treats each network as an interface, and hello messages are not sent out or received over the non-primary interface. In this way, the router link state advertisement (LSA) includes information to advertise that the primary network is

a transit network and the secondary networks are stub networks, thereby preventing any traffic from being routed from a source in the secondary network.

Interface-based routing protocols (for example, OSPF) can be configured on per VLAN basis. A routing protocol cannot be configured on an individual primary or secondary interface. Configuring a protocol parameter on a VLAN automatically configures the parameter on all its associated primary and secondary interfaces. The same logic applies to configuring IP forwarding, for example, on a VLAN.

Routing protocols in the multinetted environment advertise the secondary subnets to their peers in their protocol exchange process. For example, for OSPF the secondary subnets are advertised as stub networks in router LSAs. RIP also advertises secondary subnets to its peers residing on the primary subnet.

OSPF. This section describes the behavior of OSPF in an IPv4 multinetting environment:

- Each network is treated as an interface, and hello messages are not sent out or received over the non-primary interface. In this way, the router LSA includes information to advertise that the primary network is a transit network and the secondary networks are stub networks, thereby preventing any traffic from being routed from a source in the secondary network.
- Any inbound OSPF control packets from secondary interfaces are dropped.
- Direct routes corresponding to secondary interfaces can be exported into the OSPF domain (by enabling export of direct routes), if OSPF is not enabled on the container VLAN.
- When you create an OSPF area address range for aggregation, you must consider the secondary subnet addresses for any conflicts. That is, any secondary interface with the exact subnet address as the range cannot be in another area.
- The automatic selection algorithm for the OSPF router ID considers the secondary interface addresses also. The numerically highest interface address is selected as the OSPF router-id.

RIP. This section describes the behavior of the Routing Information Protocol (RIP) in an IP multinetting environment:

- RIP does not send any routing information update on the secondary interfaces. However, RIP does advertise networks corresponding to secondary interfaces in its routing information packet to the primary interface.
- Any inbound RIP control packets from secondary interfaces are dropped.
- Direct routes corresponding to secondary interfaces can be exported into the RIP domain (by enabling export of direct routes), if RIP is not enabled on the container VLAN.

BGP. There are no behavioral changes in the Border Gateway Protocol (BGP) in an IP multinetting environment. This section describes a set of recommendations for using BGP with IP multinetting:

- Be careful of creating a BGP neighbor session with a BGP speaker residing in secondary subnet. This situation can lead to routing loops.
- All secondary subnets are like stub networks, so you must configure BGP in such a way that the BGP next hop becomes reachable using the primary subnet of a VLAN.
- When setting the BGP next hop using an inbound or outbound policy, ensure that the next hop is reachable from the primary interface.
- A BGP static network's reachability can also be resolved from the secondary subnet.
- Secondary interface addresses can be used as the source interface for a BGP neighbor.
- Direct routes corresponding to secondary interfaces can be exported into the BGP domain (by enabling export of direct routes).

IS-IS. This section describes the behavior of IS-IS in an IPv4 multinetting environment:

- IS-IS includes all the interface addresses in its reachability information. Adjacency is established only based on the primary interface address. If the adjacency-check option is disabled by the `disable isis adjacency-check` command, then IS-IS adjacency is established irrespective of the subnet address match.

IGMP Snooping and IGMP

Internet Group Management Protocol (IGMP) snooping and IGMP treat the VLAN as an interface.

Only control packets with a source address belonging to the IP networks configured on that interface are accepted. IGMP accepts membership information that originates from hosts in both the primary and secondary subnets. The following describes the changes in behavior of IGMP in an IP multinetting environment:

- A Layer 3 VLAN always uses the primary IP address as the source address to send out an IGMP query, and querier election is based on the primary IP address of interface. Because the RFC dictates that there is only one querier per physical segment, the querier may be attached to any of configured IP interfaces, including secondary interfaces, although this is not a recommended configuration.
- For a static IGMP group, the membership report is also sent out using the primary IP address.
- For local multicast groups such as 224.0.0.X, the membership report is sent out using the first IP address configured on the interface, which is the primary IP address in ExtremeXOS.
- The source IP address check is disabled for any IGMP control packets (such as IGMP query and IGMP membership report). Source IP address checking for IGMP control packet is disabled for *all* VLANs, not just the multinetted VLANs.

Multicast Routing Protocols

For Protocol-Independent Multicast (PIM), the following behavior changes should be noted in a multinetting environment:

- PIM does not peer with any other PIM router on a secondary subnet.
- PIM also processes data packets from the hosts secondary subnets.
- PIM also accepts membership information from hosts on secondary subnets.

EAPS, ESRP, and STP

Control protocols like Ethernet Automatic Protection Switching (EAPS), Extreme Standby Router Protocol (ESRP), and the Spanning Tree Protocol (STP) treat the VLAN as an interface. If the protocol control packets are exchanged as Layer 3 packets, then the source address in the packet is validated against the IP networks configured on that interface.

DHCP Server

The Dynamic Host Configuration Protocol (DHCP) server implementation in ExtremeXOS only supports address allocation on the primary IP interface of the configured VLAN. That is, all DHCP clients residing on a bridging domain have IP addresses belonging to the primary subnet. To add a host on secondary subnet, you must manually configure the IP address information on that host.

DHCP Relay

When the switch is configured as a DHCP relay agent, it forwards the DHCP request received from a client to the DHCP server. When doing so, the system sets the GIADDR field in the DHCP request packet to the primary IP address of the ingress VLAN. This means that the DHCP server that resides on a remote subnet allocates an IP address for the client in the primary subnet range.

VRRP

Virtual Router Redundancy Protocol (VRRP) protection can be provided for the primary as well as for the secondary IP addresses of a VLAN. For multinetting, the IP address assigned to an VRRP virtual router identifier (VRID) can be either the primary or the secondary IP addresses of the corresponding VLAN.

For example, assume a VLAN *v1* with two IP addresses: a primary IP address of 10.0.0.1/24, and a secondary IP address of 20.0.0.1/24.

To provide VRRP protection to such a VLAN, you must configure one of the following:

- Configure VRRP in VLAN *v1* with two VRRP VRIDs. One VRID should have the virtual IP address 10.0.0.1/24, and the other VRID should have the virtual IP address 20.0.0.1/24. The other VRRP router, the one configured to act as backup, should be configured similarly.

—OR—

- Configure VRRP in VLAN *v1* with two VRRP VRIDs. One VRID should have the virtual IP address as 10.0.0.1/24, and the other VRID should have the virtual IP address as 20.0.0.1/24.

It is possible for a VRRP VR to have additional virtual IP addresses assigned to it. In this case, the following conditions must be met:

- Multiple virtual IP addresses for the same VRID must be on the same subnet.
- Multiple virtual IP addresses must all not be owned by the switch.

Assuming a VLAN *v1* that has IP addresses 1.1.1.1/24 and 2.2.2.2/24, here are some more examples of valid configurations:

- VRRP VR on *v1* with VRID of 99 with virtual IP addresses of 1.1.1.2 and 1.1.1.3
- VRRP VR on *v1* with VRID of 100 with virtual IP addresses of 2.2.2.3 and 2.2.2.4
- VRRP VR on *v1* with VRID of 99 with virtual IP addresses of 1.1.1.98 and 1.1.1.99
- VRRP VR on *v1* with VRID of 100 with virtual IP addresses of 2.2.2.98 and 2.2.2.99

Given the same VLAN *v1* as above, here are some invalid configurations:

- VRRP VR on *v1* with VRID of 99 with virtual IP addresses of 1.1.1.1 and 2.2.2.2 (the virtual IP addresses are not on the same subnet)
- VRRP VR on *v1* with VRID of 100 with virtual IP addresses of 2.2.2.2 and 1.1.1.1 (the virtual IP addresses are not on the same subnet)
- VRRP VR on *v1* with VRID of 99 with virtual IP addresses of 1.1.1.1 and 1.1.1.99 (one virtual IP address is owned by the switch and one is not)
- VRRP VR on *v1* with VRID of 100 with virtual IP addresses of 2.2.2.2 and 2.2.2.99 (one virtual IP address is owned by the switch and one is not).

Configuring IPv4 Multinetting

You configure IP multinetting by adding a secondary IP address to a VLAN. Use the following command to add a secondary IP address:

```
configure vlan <vlan_name> add secondary-ipaddress [<ip_address> {<netmask>} | <ipNetmask>]
```

After you have added a secondary IP address, you cannot change the primary IP address of a VLAN until you first delete all the secondary IP addresses. To delete secondary IP addresses, use the following command:

```
configure vlan <vlan_name> delete secondary-ipaddress [<ip_address> | all]
```

IP Multinetting Examples

The following example configures a switch to have one multinetted segment (port 5:5) that contains three subnets (192.168.34.0/24, 192.168.35.0/24, and 192.168.37.0/24).

```
configure default delete port 5:5
create vlan multinet
configure multinet ipaddress 192.168.34.1/24
configure multinet add secondary-ipaddress 192.168.35.1/24
configure multinet add secondary-ipaddress 192.168.37.1/24
configure multinet add port 5:5
enable ipforwarding
```

The following example configures a switch to have one multinetted segment (port 5:5) that contains three subnets (192.168.34.0, 192.168.35.0, and 192.168.37.0). It also configures a second multinetted segment consisting of two subnets (192.168.36.0 and 172.16.45.0). The second multinetted segment spans three ports (1:8, 2:9, and 3:10). RIP is enabled on both multinetted segments.

```
configure default delete port 5:5
create vlan multinet
configure multinet ipaddress 192.168.34.1
configure multinet add secondary-ipaddress 192.168.35.1
configure multinet add secondary-ipaddress 192.168.37.1
configure multinet add port 5:5
configure default delete port 1:8, 2:9, 3:10
create vlan multinet_2
configure multinet_2 ipaddress 192.168.36.1
configure multinet_2 add secondary-ipaddress 172.16.45.1
configure multinet_2 add port 1:8, 2:9, 3:10
configure rip add vlan multinet
configure rip add vlan multinet_2
enable rip
enable ipforwarding
```

DHCP/BOOTP Relay

The following sections describe how to use the Dynamic Host Configuration Protocol (DHCP)/BOOTP Relay feature:

- [Managing DHCP/BOOTP Relay on page 1289](#)
- [Configuring the DHCP Relay Agent Option \(Option 82\) at Layer 3 on page 1291](#)
- [Viewing the DHCP/BOOTP Relay Statistics and Configuration on page 1293](#)



NOTE

This section discusses DHCP/BOOTP relay operation at Layer 3. For information on DHCP/BOOTP relay operation at Layer 2, see [“Configuring the DHCP Relay Agent Option \(Option 82\) at Layer 2” on page 902](#).

BOOTP Relay agent of DHCPv6 relays the DHCPv6 messages between the server/client across sub-nets of a larger IPv6 network. The DHCPv6 server/BOOTP relay agent listens to UDP port 547.

A relay agent relays both messages from clients and Relay-forward messages from other relay agents. When a relay agent receives a valid message, it constructs a new Relay-forward message and option from the DHCP message received, then forwards it to the next hop/server. The server responds with the corresponding IP address or configuration through a Relay-Reply message to its peer, and thus to the client.

The ExtremeXOS implementation of DHCPv6 takes reference from ISC DHCPv6.

Managing DHCP/BOOTP Relay

After IP unicast routing has been configured, you can configure the switch to forward DHCP or BOOTP requests coming from clients on subnets being serviced by the switch and going to hosts on different subnets. This feature can be used in various applications, including DHCP services between Windows NT servers and clients running Windows 95.



NOTE

If DHCP/BOOTP Relay is enabled on a per VLAN basis, make sure it is enabled on both the client-side and server-side VLANs.



NOTE

You can enable the use of LSP next hops, or you can enable DHCP/BOOTP relay. The software does not support both features at the same time.

Configuring DHCPv6 BOOTP Relay

To configure the relay function:

1 Configure VLANs and IP unicast routing.



NOTE

As in DHCPv4, when you create an IPV6 VLAN interface, the corresponding disabledV6VlanList has an entry. The VLAN interface entry is removed whenever the bootpRelayv6 for the respective VLAN is enabled, and vice versa.

2 Enable the DHCP or BOOTP relay function, using the following command:

```
enable bootprelay {ipv4 | ipv6} {vlan [<vlan_name>] | {{vr} <vr_name>} | all
[{{vr} <vr_name>}}
enable bootprelay {{vlan} [<vlan_name>] | {{vr} <vr_name>} | all [{{vr} <vr_name>}}]
```

3 Configure the addresses to which DHCP or BOOTP requests should be directed, using the following command:

```
configure bootprelay [{ipv4} {vlan [<vlan_name>]} [add <ip_address> | delete
[<ip_address>|all]] | ipv6 {vlan [<vlan_name>]} [add <ipv6_address> | delete
[<ipv6_address>|all]]] {vr [<vrid>]}
configure bootprelay add <ip_address> {vr <vrid>}
```



NOTE

Use the configure command to set up a unique interface-id. It can be MAC-ID or port-vlan combination. You can also use this command to set up dhcpv6 server/next hop for each VLAN interface, or across VR. A configuration applied to the VR level is populated to all VLAN V6 interfaces.

To delete an entry, use the following command:

```
configure bootprelay delete [<ip_address> | all] {vr <vrid>}
```

To disable BOOTP relay on one or more VLANs, use the following command:

```
disable bootprelay {ipv4 | ipv6} {vlan [<vlan_name>] | {{vr} <vr_name>} | all
[{{vr} <vr_name>}}
disable bootprelay {{vlan} [<vlan_name>] | {{vr} <vr_name>} | all [{{vr}
<vr_name>}}]
```



NOTE

When VRRP and BOOTP/DHCP relay are both enabled on the switch, the relayed BOOTP agent IP address is the actual switch IP address, not the virtual IP address.

Configuring the DHCP Relay Agent Option (Option 82) at Layer 3

After configuring and enabling the DHCP/BOOTP relay feature, you can enable the DHCP relay agent option feature. This feature inserts a piece of information, called option 82, into any DHCP request packet that is to be relayed by the switch. Similarly, if a DHCP reply received by the switch contains a valid relay agent option, the option is stripped from the packet before it is relayed to the client.

When DHCP option 82 is enabled, two types of packets need to be handled:

- **DHCP Request:** When the switch (relay agent) receives a DHCP request, option 82 is added at the end of the packet. If the option has already been enabled, then the action taken depends on the configured policy (drop packet, keep existing option 82 value, or replace the existing option). If the incoming DHCP request is tagged, then that VLAN ID is added to the circuit ID sub option of option 82; otherwise, the default VLAN ID is added.
- **DHCP Reply:** When the option 82 information check is enabled, the packets received from the DHCP server are checked for option 82 information. If the remote ID sub-option is the switch's MAC address, the packet is sent to the client; if not, the packet is dropped. If the check is not enabled, the packets are forwarded as-is.

The DHCP relay agent option consists of two pieces of data, called sub-options. The first is the agent circuit ID sub-option, and the second is the agent remote ID sub-option. When the DHCP relay agent option is enabled on switches running ExtremeXOS, the value of these sub-options is set as follows:

- **Agent circuit ID sub-option:** The full circuit ID string uses the format <vlan_info>-<port_info>. You can use the default values for vlan_info and port_info, or you can configure these values as described later in this section.
- **Agent remote ID sub-option:** Always contains the Ethernet MAC address of the relaying switch. You can display the Ethernet MAC address of the switch by issuing the `show switch` command.



NOTE

For more general information about the DHCP relay agent information option, refer to RFC 3046.

The following sections describe how to manage this feature:

- [Enabling and Disabling the DHCP Relay Agent Option on page 1292](#)
- [Enabling and Disabling DHCP Packet Checking on page 1292](#)
- [Configuring the DHCP Packet Handling Policy on page 1292](#)
- [Configuring the DHCP Agent Circuit ID Suboption on page 1293](#)

Enabling and Disabling the DHCP Relay Agent Option

To enable the DHCP relay agent option, use the following command after configuring the DHCP/BOOTP relay function:

```
configure bootrelay dhcp-agent information option
```

To disable the DHCP relay agent option, use the following command:

```
unconfigure bootrelay dhcp-agent information option
```

Enabling and Disabling DHCP Packet Checking

In some instances, a DHCP server may not properly handle a DHCP request packet containing a relay agent option. To prevent DHCP reply packets with invalid or missing relay agent options from being forwarded to the client, use the following command:

```
configure bootrelay dhcp-agent information check
```

To disable checking of DHCP replies, use this command:

```
unconfigure bootrelay dhcp-agent information check
```

Configuring the DHCP Packet Handling Policy

A DHCP relay agent may receive a client DHCP packet that has been forwarded from another relay agent. If this relayed packet already contains a relay agent option, then the switch handles this packet according to the configured DHCP relay agent option policy. The possible actions are to replace the option information, to keep the information, or to drop packets containing option 82 information. To configure this policy, use the following command:

```
configure bootrelay dhcp-agent information policy [drop | keep | replace]
```

The default relay policy is replace. To configure the policy to the default, use this command:

```
unconfigure bootrelay dhcp-agent information policy
```

Configuring the DHCP Agent Circuit ID Suboption

To configure the values used to create the agent circuit ID suboption, use the following commands:

```
configure bootrelay dhcp-agent information circuit-id port-information <port_info>
port <port>
```

```
configure bootrelay dhcp-agent information circuit-id vlan-information <vlan_info>
{vlan} [<vlan_name>|all]
```

Viewing the DHCP/BOOTP Relay Statistics and Configuration

To view the DHCP/BOOTP relay statistics and configuration, use the following command:

```
show bootrelay
```

To view the BOOTP relay enable/disable configuration, use the following command:

```
show bootrelay configuration {{vlan} <vlan_name> | {vr} <vr_name>}
```

To view the DHCP relay agent option (Option 82) configuration, use the following commands:

```
show bootrelay dhcp-agent information circuit-id port-information ports all
show bootrelay dhcp-agent information circuit-id vlan-information
```

Broadcast UDP Packet Forwarding

UDP Forwarding is a flexible and generalized routing utility for handling the directed forwarding of broadcast UDP packets. UDP Forwarding enables you to configure your switch so that inbound broadcast UDP packets on a VLAN are forwarded to a particular destination IP address or VLAN. UDP Forwarding allows applications, such as multiple DHCP relay services from differing sets of VLANs, to be directed to different DHCP servers.

The following rules apply to UDP broadcast packets handled by this feature:

- If the UDP profile includes BOOTP or DHCP, it is handled according to guidelines specified in RFC 1542.
- If the UDP profile includes other types of traffic, these packets have the IP destination address modified as configured, and changes are made to the IP and UDP checksums and TTL field (decrements), as appropriate.

If UDP Forwarding is used for BOOTP or DHCP forwarding purposes, do not configure or use the existing `bootprelay` function. However, if the previous `bootprelay` functions are adequate, you may continue to use them.

**NOTE**

When using `udp-profile` to forward dhcp request, the behavior will be different from `bootprelay`. Where `bootprelay` will forward the dhcp packet with the client vlan IP as source IP, `udp-profile` will forward the dhcp packet with the source IP of the egress vlan towards the destination server.

**NOTE**

UDP Forwarding only works across a Layer 3 boundary and currently, UDP Forwarding can be applied to IPv4 packets only, not to IPv6 packets.

The following section provide information on using broadcast UDP packet forwarding:

- [Configuring UDP Forwarding on page 1294](#)
- [Configuring UDP Echo Server Support on page 1296](#)

Configuring UDP Forwarding

To configure UDP Forwarding, create a policy file for your UDP profile, and then associate the profile with a VLAN using the following command:

```
configure vlan <vlan_name> udp-profile [<profilename> | none]
```

You can apply a UDP Forwarding policy only to an L3 VLAN (a VLAN having at least one IP address configured on it). If no IP address is configured on the VLAN, the command is rejected.

UDP profiles are similar to ACL policy files. UDP profiles use a subset of the match conditions allowed for ACLs. Unrecognized attributes are ignored. A UDP forwarding policy must contain only the following attributes:

- Match attributes
 - Destination UDP port number (`destination-port`)
 - Source IP address (`source-ipaddress`)
- Action modified (`set`) attributes
 - Destination IP address (`destination-ipaddress`)
 - VLAN name (`vlan`)

Policy files used for UDP forwarding are processed differently from standard policy files. Instead of terminating when an entry's match clause becomes true, each entry in the policy file is processed and the corresponding action is taken for each true match clause.

For example, if the following policy file is used as a UDP forwarding profile, any packets destined for UDP port 67 are sent to IP address 20.0.0.5 *and* flooded to VLAN *to7*:

```
entry one {
  if match all {
    destination-port 67 ;
  } then {
```

```

        destination-ipaddress 20.0.0.5 ;
    }
}

entry two {
    if match all {
        destination-port 67 ;
    } then {
        vlan "to7" ;
    }
}

```

If you include more than one VLAN set attribute or more than one destination-ipaddress set attribute in one policy entry, the last one is accepted and the rest are ignored.

**NOTE**

Although the XOS policy manager allows you to set a range for the destination-port, you should not specify the range for the destination-port attribute in the match clause of the policy statement for the UDP profile. If a destination-port range is configured, the last port in the range is accepted and the rest are ignored.

You can have two valid set statements in each entry of a UDP forwarding policy; one a destination-ipaddress and one a VLAN. The ExtremeXOS software currently allows a maximum of eight entries in a UDP forwarding policy, so you can define a maximum of 16 destinations for one inbound broadcast UDP packet: eight IP addresses and eight VLANs.

**NOTE**

It is strongly advised to have no more than eight entries in a UDP forwarding profile. The UDP forwarding module processes those entries even if the entries do not contain any attributes for UDP forwarding. Having more than eight entries drastically reduces the performance of the system. If the inbound UDP traffic rate is very high, having more than eight entries could cause the system to freeze or become locked.

**NOTE**

If you rename a VLAN referred to in your UDP forwarding profile, you must manually edit the policy to reflect the new name, and refresh the policy.

You can also validate whether the UDP profile has been successfully associated with the VLAN by using the `show policy` command. UDP Forwarding is implemented as part of the netTools process, so the command does display netTools as a user of the policy.

**NOTE**

When using UDP profile to forward DHCP requests, the behavior is different from bootprelay. Where bootprelay forwards the DHCP packet with the client VLAN IP as the source IP, DHCP profile forwards the DHCP packet with the source IP of the egress toward the destination server.

To remove a policy, use the none form of the following command:

```
configure vlan <vlan_name> udp-profile [<profilename> | none]
```

or use this command:

```
unconfigure vlan <vlan_name> udp-profile
```

For more information about creating and editing policy files, see [Chapter 17, “Policy Manager.”](#) For more information about ACL policy files, see [Chapter 18, “ACLs.”](#)

Configuring UDP Echo Server Support

You can use UDP echo packets to measure the transit time for data between the transmitting and receiving ends.

To enable UDP echo server support, use the following command:

```
enable udp-echo-server {vr <vrid>}{udp-port <port>}
```

To disable UDP echo server support, use the following command:

```
disable udp-echo-server {vr <vrid>}
```

IP Broadcast Handling

The ExtremeXOS software supports IP subnet directed broadcast forwarding. In the ExtremeXOS software, IP subnet directed broadcast forwarding is done in the software by default; if you want to perform forwarding in the hardware, see the command reference pages on IP forwarding in the *ExtremeXOS Command Reference Guide*.

The following sections provide more information on the IP broadcast handling feature:

- [IP Broadcast Handling Overview on page 1296](#)
- [Command-line Support for IP Broadcast Handling on page 1295](#)

IP Broadcast Handling Overview

To understand how IP broadcast handling functions in the ExtremeXOS software, consider the following two examples.

For the first example, a system sends an IP packet (such as the IP packet generated by the `ping` command) to an IP subnet directed broadcast address which is directly connected to that system. In this case, the IP packet goes out as a Layer 2 broadcast with the destination media access control (DMAC) addresses all set to `FF`, while the source media access control (SMAC) is set to the system MAC. This packet is sent out of all the ports of the VLAN.

In the second example, a system sends a packet (such as the IP packet generated by the `ping` command) to an IP subnet directed broadcast address which is remotely connected through a gateway. In this case, the IP packet goes out as a Layer 2 unicast packet with the DMAC equal to the gateway's MAC address, while the SMAC is set to the system MAC. At the gateway router, the existing IP packet forwarding mechanism is sufficient to send the packet out of the correct interface if the router is not the final hop router.

When the packet reaches the final hop router, which is directly connected to the target IP subnet, IP directed broadcast forwarding needs to be turned on. The IP broadcast handling feature is applicable only at the final hop router directly attached to the target subnet. At the final hop router, when IP subnet directed broadcast forwarding is enabled on an IP VLAN via the command line, the following happens:

- Some basic validity checks are performed (for example, a check to see if the VLAN has IP enabled)
- A subnet broadcast route entry for the subnet is installed. For example, consider a system with the following configuration:

```
VLAN-A = 10.1.1.0/24, ports 1:1, 1:2, 1:3, 1:4
```

```
VLAN-B = 20.1.1.0/24, ports 1:5, 1:6, 1:7, 1:8
```

```
VLAN-C = 30.1.1.0/24, ports 1:9, 1:10, 1:11
```

If you enable IP directed broadcast forwarding on VLAN-A, you should install a route entry for 10.1.1.255 on this system.

- A packet arriving on port 1:5 VLAN-B with destination IP (DIP) set to 10.1.1.255, the source IP (SIP) set to 20.1.1.3, the DMAC set to the router MAC, and the SMAC set to the originating system MAC, arrives at the installed route entry and is sent out on all the ports of VLAN-A, with DMAC set to be all FF and the SMAC set to the router's system MAC.
- An IP packet arriving on port 1:1 VLAN-A with the DIP set to 10.1.1.255, the SIP set to 10.1.1.3, the DMAC set to all FF, and the SMAC set to the originator's MAC, causes Layer 2 flooding on all ports of VLAN-A.

When IP subnet directed broadcast is disabled on an IP VLAN, it is disabled on all VLAN ports and all IP subnet directed broadcast entries are deleted.



NOTE

IP subnet directed broadcast uses fast-path forwarding.

VLAN Aggregation



NOTE

This feature is supported only on the platforms listed for this feature in the license tables in [Appendix A, "Feature License Requirements"](#)

VLAN aggregation is a feature aimed primarily at service providers. The purpose of VLAN aggregation is to increase the efficiency of IP address space usage. It does this by allowing clients within the same IP subnet to use different broadcast domains while still using the same default router.

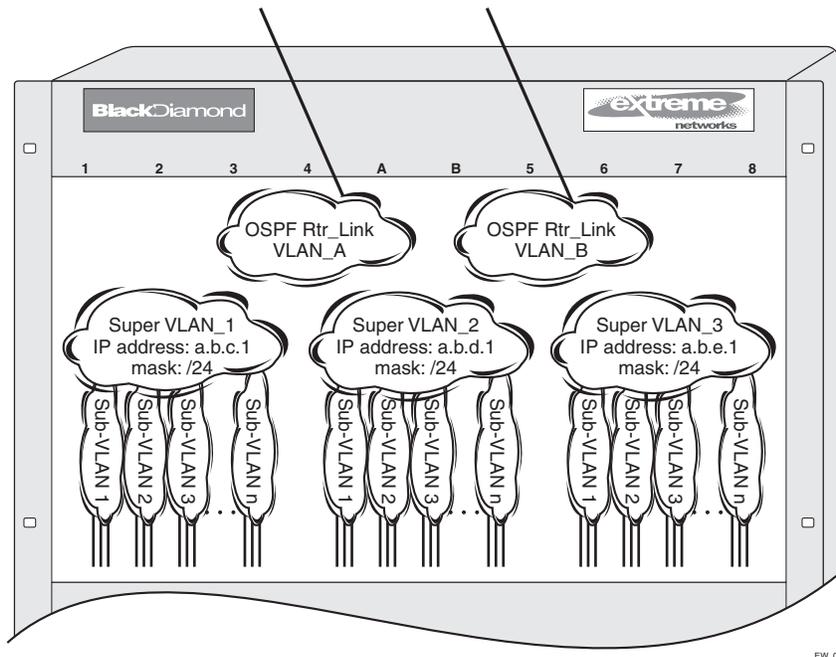
Using VLAN aggregation, a *superVLAN* is defined with the desired IP address. The subVLANs use the IP address of the superVLAN as the default router address. Groups of clients are then assigned to subVLANs that have no IP address, but are members of the superVLAN. In addition, clients can be informally allocated any valid IP addresses within the subnet. Optionally, you can prevent communication between subVLANs for isolation purposes. As a result, subVLANs can be quite small, but allow for growth without re-defining subnet boundaries.

Without using VLAN aggregation, each VLAN has a default router address, and you need to use large subnet masks. The result of this is more unused IP address space.

Multiple secondary IP addresses can be assigned to the superVLAN.

Figure 211 illustrates VLAN aggregation.

Figure 197: VLAN Aggregation



In Figure 211, all stations are configured to use the address 10.3.2.1 for the default router.

The following sections provide more information on the VLAN aggregation feature:

- [VLAN Aggregation Properties on page 1298](#)
- [VLAN Aggregation Limitations on page 1299](#)
- [SubVLAN Address Range Checking on page 1299](#)
- [Isolation Option for Communication Between SubVLANs on page 1299](#)
- [VLAN Aggregation Example on page 1300](#)
- [Verifying the VLAN Aggregation Configuration on page 1300](#)

VLAN Aggregation Properties

VLAN aggregation is a very specific application, and the following properties apply to its operation:

- All broadcast and unknown traffic remains local to the subVLAN and does not cross the subVLAN boundary. All traffic within the subVLAN is switched by the subVLAN, allowing traffic separation between subVLANs (while using the same default router address among the subVLANs).
- Hosts can be located on the superVLAN or on subVLANs. Each host can assume any IP address within the address range of the superVLAN router interface. Hosts on the subVLAN are expected to have the same network mask as the superVLAN and have their default router set to the IP address of the superVLAN.

- All IP unicast traffic between subVLANs is routed through the superVLAN. For example, no ICMP redirects are generated for traffic between subVLANs, because the superVLAN is responsible for subVLAN routing. Unicast IP traffic across the subVLANs is facilitated by the automatic addition of an ARP entry (similar to a proxy ARP entry) when a subVLAN is added to a superVLAN. This feature can be disabled for security purposes.

VLAN Aggregation Limitations

The following limitations apply to VLAN aggregation:

- No additional routers may be located in a subVLAN. This feature is only applicable for “leaves” of a network.
- A subVLAN cannot be a superVLAN, and vice-versa.
- SubVLANs are not assigned an IP address.
- A subVLAN should belong to only one superVLAN.
- A subVLAN or superVLAN should not be added to a private VLAN
- Before you can delete a superVLAN, you must delete all subVLANs in that superVLAN.
- When configuring a subVLAN address range, all addresses in the range must belong to the superVLAN subnet.

SubVLAN Address Range Checking

You can configure subVLAN address ranges on each subVLAN to prohibit the entry of IP addresses from hosts outside of the configured range.

To configure a subVLAN range, use the following command:

```
configure vlan <vlan_name> subvlan-address-range <ip address1> - <ip address2>
```

To remove a subVLAN address range, use the following command:

```
unconfigure vlan <vlan_name> subvlan-address-range
```

To view the subVLAN address range, use the following command:

```
show vlan {virtual-router <vr-name>}
```

Isolation Option for Communication Between SubVLANs

To facilitate communication between subVLANs, by default, an entry is made in the IP ARP table of the superVLAN that performs a proxy ARP function. This allows clients on one subVLAN to communicate with clients on another subVLAN. In certain circumstances, intra-subVLAN communication may not be desired for isolation reasons.

To prevent normal communication between subVLANs, disable the automatic addition of the IP ARP entries on the superVLAN using the following command:

```
disable subvlan-proxy-arp vlan [<vlan-name> | all]
```



NOTE

The isolation option works for normal, dynamic, ARP-based client communication.

VLAN Aggregation Example

The following example illustrates how to configure VLAN aggregation. The VLAN *vsuper* is created as a superVLAN, and subVLANs, *vsub1*, *vsub2*, and *vsub3* are added to it.

- 1 Create and assign an IP address to a VLAN designated as the superVLAN. Be sure to enable IP forwarding and any desired routing protocol on the switch.

```
create vlan vsuper
configure vsuper ipaddress 192.201.3.1/24
enable ipforwarding
enable ospf
configure ospf add vsuper area 0
```

- 2 Create and add ports to the subVLANs.

```
create vlan vsub1
configure vsub1 add port 10-12
create vlan vsub2
configure vsub2 add port 13-15
create vlan vsub3
configure vsub3 add port 16-18
```

- 3 Configure the superVLAN by adding the subVLANs.

```
configure vsuper add subvlan vsub1
configure vsuper add subvlan vsub2
configure vsuper add subvlan vsub3
```

- 4 Optionally, disable communication among subVLANs.

```
disable subvlan-proxy-arp vlan all
```



NOTE

The above command has no impact on Layer 3 traffic.

Verifying the VLAN Aggregation Configuration

The following commands can be used to verify proper VLAN aggregation configuration:

- `show vlan`—Indicates the membership of subVLANs in a superVLAN.
- `show iparp`—Indicates an ARP entry that contains subVLAN information. Communication with a client on a subVLAN must have occurred in order for an entry to be made in the ARP table.

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CHAPTER

IPv6 Unicast Routing

This chapter includes feature descriptions and configuration details in the following sections:

- [Overview on page 1248](#)
- [Neighbor Discovery Protocol on page 1251](#)
- [Managing Neighbor Discovery on page 1252](#)
- [Managing Duplicate Address Detection on page 1255](#)
- [Unique Local Address \(ULA\) for IPv6 on page 1261](#)
- [Managing IPv6 Unicast Routing on page 1261](#)
- [Configuring Basic IP Unicast Routing on page 1261](#)
- [Managing Router Discovery on page 1262](#)
- [Managing Tunnels on page 1263](#)
- [Verifying the IP Unicast Routing Configuration on page 1264](#)
- [Managing IPv6 Routes and Hosts in External Tables on page 1264](#)
- [Configuring Route Compression on page 1265](#)
- [Hardware Forwarding Behavior on page 1265](#)
- [Hardware Forwarding Limitations on page 1266](#)
- [Hardware Tunnel Support on page 1267](#)
- [Routing Configuration Example on page 1267](#)
- [Tunnel Configuration Examples on page 1269](#)

This chapter assumes that you are already familiar with IPv6 unicast routing. If not, refer to the following publications for additional information:

- RFC 2460—*Internet Protocol, Version 6 (IPv6) Specification*
- RFC 3513—*Internet Protocol Version 6 (IPv6) Addressing Architecture*



NOTE

For more information on interior gateway protocols, see [Chapter 34, “RIPng,”](#) or [Chapter 36, “OSPFv3.”](#)

Overview

The switch provides full Layer 3, IPv6 unicast routing. It exchanges routing information with other routers on the network using the IPv6 versions of the following protocols:

- Routing Information Protocol (RIPng)
- Open Shortest Path First (OSPFv3)
- Intermediate System-Intermediate System (IS-IS)

The switch dynamically builds and maintains a routing table and determines the best path for each of its routes.

The ExtremeXOS software can provide both IPv4 and IPv6 routing at the same time. Separate routing tables are maintained for the two protocols. Most commands that require you to specify an IP address can now accept either an IPv4 or IPv6 address and act accordingly. Additionally, many of the IP configurations, enabling, and display commands have added tokens for IPv4 and IPv6 to clarify the version for which the command applies. For simplicity, existing commands affect IPv4 by default and require you to specify IPv6, so configurations from an earlier release will still correctly configure an IPv4 network.

ACLs and routing policies also support IPv6. Use of an IPv6 address in a rule entry will automatically use IPv6.

The following sections provide additional information on IPv6 unicast routing:

- [Router Interfaces on page 1248](#)
- [Tunnels on page 1249](#)
- [Specifying IPv6 Addresses on page 1249](#)
- [Neighbor Discovery Protocol on page 1251](#)
- [IPv6 Router Advertisement Options for DNS on page 1253](#)
- [IPv6 Router Advertisement Filtering on page 1254](#)
- [Managing Duplicate Address Detection on page 1255](#)
- [Populating the Routing Table on page 1258](#)

Router Interfaces

The routing software and hardware routes IPv6 traffic between router interfaces. A router interface is either a virtual LAN (VLAN) that has an IP address assigned to it, or a Layer 3 tunnel.

As you create VLANs and tunnels with IP addresses, you can also choose to route (forward traffic) between them. Both the VLAN switching and IP routing function occur within the switch.

IPv4 and IPv6 interfaces can coexist on the same VLAN, allowing both IPv4 and IPv6 networks to coexist on the same Layer 2 broadcast domain.



NOTE

Each IP address and mask assigned to a VLAN must represent a unique IP subnet. You cannot configure the same IP address and subnet on different VLANs within the same virtual router.

Tunnels

The ExtremeXOS software supports Layer 3 tunnels, which serve as a transition option, as networks change over from IPv4 to IPv6. The software supports these tunnels in *Default-VR*.



NOTE

IPv6 tunnels are supported only in Default-VR.

The ExtremeXOS software supports the use of IPv6-in-IPv4 tunnels (known as configured tunnels or 6in4 tunnels) and IPv6-to-IPv4 tunnels (known as 6to4 tunnels). Both types of tunnels are used to connect regions of IPv6 routing across a region of IPv4 routing. From the perspective of the router, the tunnel across the IPv4 region is one hop, even if multiple IPv4 routers are traversed during transport.

A 6in4 tunnel connects one IPv6 region to one other IPv6 region. Multiple 6in4 tunnels can be configured on a single router to connect with multiple IPv6 regions. Dynamic and static routing can be configured across a 6in4 tunnel. Hosts in the IPv6 regions need not know anything about the configured tunnel, since packets destined for remote regions are sent over the tunnel like any other type of routing interface.

A 6to4 tunnel connects one IPv6 region with multiple IPv6 regions. Only one 6to4 tunnel can be configured on a single router.

Specifying IPv6 Addresses

IPv6 Addresses are 128 bits (16 bytes) when compared to the 32 bit IPv4 addresses. The ExtremeXOS software accepts two standard representations for IPv6 addresses, as described in RFC 3513, section 2.2, items 1, 2, and 3.

For example, the 128 bits of the address can be represented by eight, four-digit hexadecimal numbers separated by colons:

```
2000:af13:ee10:34c5:800:9192:ba89:2311
3f11:5655:2300:304:0000:0000:7899:acde
```

Leading zeros in a four-digit group can be omitted. There is a special use of a double colon (::) in an address. The double colon stands for one or more groups of 16 bits of zeros and can only be used once in an address. For example, the following addresses:

```
fe80:0:0:0:af34:2345:4afe:0
fe80:0:0:111:0:0:fe11
3c12:0:0:0:89:ff:3415
```

can be represented as:

```
fe80::af34:2345:4afe:0
fe80:0:0:111::fe11
3c12::89:ff:3415
```

Additionally, you can specify an address in a mixed IPv4/IPv6 mode that uses six, four-digit hexadecimal numbers for the highest-order part of the address, and uses the IPv4 dotted decimal representation for the lowest-order remaining portion. For example:

```
0:0:0:0:0:0:192.168.1.1
0:0:0:0:0:ffff:10.0.14.254
```

These can be represented as:

```
::192.168.1.1
::ffff:10.0.14.254
```

Both global and link-local IP addresses can be configured on a VLAN or tunnel interface, using the following commands:

```
configure [{vlan} <vlan_name> | {tunnel} <tunnel_name>] ipaddress [ {eui64}
<ipv6_address_mask> | ipv6-link-local

configure tunnel <tunnel_name> ipaddress [ipv6-link-local | {eui64}
<ipv6_address_mask> ]
```

where <ipaddress> refers to the address specified in the above format.

The IPv6 address configuration can be verified using the following commands:

```
show vlan {virtual-router <vr-name>}show ipconfig ipv6 {vlan <vlan_name> |
tunnel <tunnelname>}
show ipconfig ipv6 {vlan <vlan_name> | tunnel <tunnelname>}
```

The following sections provide additional information on IPv6 addresses:

- [Scoped Addresses on page 1250](#)
- [IPv6 Addresses Used in Examples on page 1250](#)

Scoped Addresses

IPv6 uses a category of addresses called link-local addresses that are used solely on a local subnet. Every IPv6 VLAN must have at least one link-local address. If a global IP address is configured on a VLAN that has no link-local address, one is assigned automatically by the switch. The link-local addresses start with the prefix fe80::/64. As a result, a switch can have the same link local address assigned to different VLANs, or different neighbors on different links can use the same link local address. Because of this, there are cases where you need to specify an address and a VLAN/tunnel to indicate which interface to use. For those cases, you can indicate the interface by using a scoped address. To scope the address, append the VLAN/tunnel name to the end of the address, separated by a percent sign (%). For example, to indicate the link local address fe80::2 on VLAN finance, use the following form:

```
fe80::2%finance
```

Scoped addresses also appear in the output of display commands.

IPv6 Addresses Used in Examples

For the purposes of documentation, we follow RFC 3849, which indicates that the prefix 2001:db8::/32 can be used as a global unicast address prefix and will not be assigned to any end party.

Neighbor Discovery Protocol

The Neighbor Discovery Protocol (NDP), as defined in RFC 2461, defines mechanisms for the following functions:

- Resolving link-layer addresses of the IPv6 nodes residing on the link.
- Locating routers residing on the attached link.
- Locating the address prefixes that are located on the attached link.
- Learning link parameters such as the link MTU, or Internet parameters such as the hop limit value that has to be used in the outgoing packets.
- Automatic configuration of the IPv6 address for an interface.
- Detecting whether the address that a node wants to use is already in use by another node, also known as Duplicate Address Detection (DAD).
- Redirecting the traffic to reach a particular destination through a better first-hop.

In IPv4, MAC address resolution is done by ARP. For IPv6, this functionality is handled by NDP. The router maintains a cache of IPv6 addresses and their corresponding MAC addresses and allows the system to respond to requests from other nodes for the MAC address of the IPv6 addresses configured on the interfaces.

Also supported is router discovery—the ability to send out router advertisements that can be used by a host to discover the router. The advertisements sent out contain the prefixes and configuration parameters that allow the end nodes to auto-configure their addresses. The switch also responds to requests from nodes for router advertisements.

The following settings can be configured on an interface to manage router advertisements:

- Settings to control the sending of router advertisements over the interface periodically and to control responding to router solicitations
- The maximum time between sending unsolicited router advertisements
- The minimum time between sending unsolicited router advertisements

You can configure the following values, that are advertised by the switch:

- Managed address configuration flag
- Other stateful configuration flag
- Link MTU
- Retransmit timer
- Current hop limit
- Default lifetime
- Reachable time

Additionally, you can configure the following values for each prefix on the prefix list associated with an interface:

- Valid lifetime of the prefix
- On-link flag
- Preferred lifetime of the prefix
- Autonomous flag

**NOTE**

Unlike ExtremeWare, the ExtremeXOS software does not support host processing of neighbor router advertisements.

Managing Neighbor Discovery

The following sections describe how to manage neighbor discovery:

- [Creating and Deleting Static Entries on page 1252](#)
- [Configuring the Neighbor-Discovery Cache Size on page 1252](#)
- [Managing Neighbor-Discovery Cache Updates on page 1252](#)
- [Clearing the Neighbor-Discovery Cache on page 1253](#)
- [Returning to the Neighbor-Discovery Cache Default Configuration on page 1253](#)
- [Displaying Neighbor-Discovery Cache Entries on page 1253](#)

Creating and Deleting Static Entries

You can statically configure the MAC address of IPv6 destinations on the attached links using the following commands:

```
configure neighbor-discovery cache {vr <vr_name>} add [<ipv6address> |  
<scoped_link_local>] <mac>  
configure neighbor-discovery cache {vr <vr_name>} delete [<ipv6address> |  
<scoped_link_local>]
```

Configuring the Neighbor-Discovery Cache Size

To configure the maximum number of entries for the neighbor-discovery cache, enter the following command:

```
configure neighbor-discovery cache {vr <vr_name>} max_entries <max_entries>
```

To configure the maximum number of pending entries for the neighbor-discovery cache, enter the following command:

```
configure neighbor-discovery cache {vr <vr_name>} max_pending_entries  
<max_pending_entries>
```

Managing Neighbor-Discovery Cache Updates

To configure the timeout period for dynamic entries in the neighbor-discovery cache, enter the following command:

```
configure neighbor-discovery cache {vr <vr_name>} timeout <timeout>
```

To enable the refresh of dynamic entries in the neighbor-discovery cache before the timeout period ends, enter the following command:

```
enable neighbor-discovery {vr <vr_name>} refresh
```

To disable the refresh of dynamic entries in the neighbor-discovery cache before the timeout period ends, enter the following command:

```
disable neighbor-discovery {vr <vr_name>} refresh
```

Clearing the Neighbor-Discovery Cache

The neighbor-discovery entries that are learned dynamically can be cleared using the following command:

```
clear neighbor-discovery cache ipv6 {<ipv6address> {vr <vr_name>} | vlan <vlan_name> | vr <vr_name>}
```

Static neighbor discovery entries are never deleted, and are retained across system reboots.

Returning to the Neighbor-Discovery Cache Default Configuration

To return to the neighbor-discovery cache default configuration, use the following command:

```
unconfigure neighbor-discovery cache {vr <vr_name>}
```

Displaying Neighbor-Discovery Cache Entries

Both statically configured and dynamic neighbor-discovery entries can be viewed using the following command:

```
show neighbor-discovery {cache {ipv6}} [{<ipv6_addr> | <mac> | permanent] {vr <vr_name>}} | vlan <vlan_name> | vr <vr_name>}
```

IPv6 Router Advertisement Options for DNS

Neighbor Discovery (ND) for IP version 6 and IPv6 stateless address autoconfiguration provide ways to configure either fixed or mobile nodes with one or more IPv6 addresses, default routers, and other parameters [RFC4861][RFC4862]. ExtremeXOS now supports two RA options that provide the DNS information needed for an IPv6 host to reach Internet services.

The Recursive DNS Server (RDNSS) option contains the addresses of recursive DNS servers, and the DNS Search List (DNSSL) option for the Domain Search List that maintains parity with the DHCPv6 options, and ensures the necessary functionality to determine the search domains.

The RDNSS option contains one or more IPv6 addresses of recursive DNS servers. All of the addresses share the same lifetime value. If you wish to have different lifetime values, you can use multiple RDNSS options.

The DNSSL option contains one or more domain names of DNS suffixes. All of the domain names share the same lifetime value. If you wish to have different lifetime values, you can use multiple DNSSL options.

The existing ND message (i.e., Router Advertisement) is used to carry this information. An IPv6 host can configure the IPv6 addresses of one or more RDNSSs through RA messages. Using the RDNSS and DNSSL options, along with the prefix information option based on the ND protocol, an IPv6 host can perform the network configuration of its IPv6 address and the DNS information simultaneously without needing DHCPv6 for the DNS configuration. The RA options for RDNSS and DNSSL can be used on any network that supports the use of ND.

For IPv6-only networks that rely only on IPv6 stateless Autoconfiguration as a deployment model, these two options allow a host to configure its DNS information. This is useful when there is no DHCPv6 infrastructure, or hosts do not have a DHCPv6 client. For networks where DHCPv6 is deployed, you might not need an RA-based DNS configuration.

You can configure the RA options for DNS using the following commands:

Default RDNSS Lifetime.

```
configure {vlan} <vlan_name> router-discovery {ipv6} rdns-lifetime [<rdns_lifetime>
| infinity | auto]
```

Add RDNS Server with Optional RDNSS Lifetime.

```
configure {vlan} <vlan_name> router-discovery {ipv6} add rdns <ipaddress> {{rdns-
lifetime} [<rdns_lifetime> | infinity]}
```

Default DNSSL Lifetime.

```
configure {vlan} <vlan_name> router-discovery {ipv6} dnssl-lifetime [<dnssl_lifetime>
| infinity | auto]
```

Add a DNS suffix to DNSSL .

```
configure {vlan} <vlan_name> router-discovery {ipv6} add dnssl <dns_suffix> {{dnssl-
lifetime} [<dnssl_lifetime> | infinity]}
```

IPv6 Router Advertisement Filtering

Newly connected IPv6 hosts can automatically discover configuration details by sending link-local router solicitation messages. Once received, an IPv6 router can send IPv6 router advertisements (RAs) back to the host, that include network configuration parameters. Since IPv6 router advertisement packets are used to configure, among other things, the host's gateway address, unauthorized users employ various methods to spoof IPv6 router advertisements to redirect, or deny service.

The IPv6 Router Advertisement Filtering feature exposes the existing "icmp-type" match criteria to allow IPv6 packets to match RAs and other IPv6 packets that use the ICMPv6 protocol. This functionality provides the ability to flexibly detect certain conditions and take appropriate actions based on network design and expectations.

Limitations. This feature has the following limitations:

- Only ingress ACLs support the "icmp-type" match criteria for IPv6 packets. This match criteria cannot be used with egress ACLs.
- The IPv6 extension header parsing varies per platform - see "Platforms Supported" section for more detail
- The IPv6 source-address and destination-address, and the ethernet-source-address and ethernet-destination-address fields cannot be matched in the same rule without enabling "double-wide" mode. Double wide mode is not available on all of the supported platforms and causes a 50% reduction of ACL hardware resources.

Supported Platforms. All Summit, BD8K, and BDX8 platforms are supported. However, there are per-platform limitations on how many IPv6 extension headers can be parsed while still matching the supplied ICMP type:

- Up to 2 extension headers: X460, X670, 8900-40G6X-xm, BD8X
- 0 extension headers: All other BD8X, BD8K, and Summit platforms

Newer chipsets have the ability to match this field when 0, 1, or 2 extension headers are present. Older chipsets have the ability to match this field only when 0 extension headers are present.

Newer chipsets include the Apollo (X460) and Trident (X670, 8900-40G6X-xm, BD8X) series. Older chipsets include all other series (including BD8K xl-series).

The exact field compatibility with this match criteria depends on the platform, but all platforms are able to match the port and protocol (ICMPv6) in single wide mode. Using double wide mode provides access to a 128-bit source address, or source MAC address, for example. All of the above platforms support double wide mode at the expense of reducing ACL scale by 50%. The XGS3 platforms do not support double wide mode at all.

On platforms that support double wide mode, if the layer-2 device is unable to identify whether the packet is an ICMPv6 Router Advertisement message, and the IPv6 Source Address of the packet is a link-local address or is unspecified, the packet is blocked.

You can also use the new “icmp-type” to match other protocol cases such as MLD and MLDv2.

CLI Commands. The existing ACL match criteria “icmp-type <type>” is exposed in dynamic ACLs and static ACL policies on the target platforms. This same match criteria is already supported for rules that specify IPv4 criteria on the target platforms.

Example Policy. Here is a policy to detect and log a “simple” RA attack, only allow TCP/UDP/ICMP/xyz protocol traffic that can be parsed (i.e., has up to 2 extension headers and, if fragmented, the L4 NH is contained in the first fragment), and deny everything else including “complex” RA attacks:

```
entry disallow_and_log_RA_attacks {if {protocol icmpv6;icmp-type 134;} then { deny;
mirror-cpu; log; count RA_attack;}}
entry allow_tcp {    if {protocol tcp; first-fragments;} then {permit;}}
entry allow_udp {    if {protocol udp; first-fragments;} then {permit;}}
entry allow_icmp {    if {protocol icmpv6; first-fragments;} then {permit;}}
entry allow_xyz...
entry denyall { if{first-fragments; } then {deny;}}
```

The above policy works for newer chipsets, but leaves (at least) the following exposure for older chipsets:

A malicious user could send an RA with a single extension header and it would be allowed to pass due to rule “allow_icmp” (newer chipsets would block this packet through the first rule). To mitigate this exposure on older chipsets, you could call out each “icmp-type” that is supported (ND, MLD, etc.), and then drop any ICMPv6 with an extension header.

For more information, please refer to <http://tools.ietf.org/html/draft-ietf-v6ops-ra-guard-implementation-04>.

Managing Duplicate Address Detection

The Duplicate Address Detection (DAD) feature checks networks attached to a switch to see if IP addresses configured on the switch are already in use on an attached network. The following sections provide additional information on the DAD feature:

- [“DAD Overview” on page 1257](#)
- [“Configuring DAD” on page 1257](#)
- [“Running a DAD Test” on page 1257](#)
- [“Displaying DAD Configuration and Statistics” on page 1258](#)
- [“Clearing the DAD Counters” on page 1258](#)

When you configure an active interface with an IPv6 address, the interface must send out an advertisement containing its address. All other interfaces on the subnet have the opportunity to respond to the newly configured interface, and inform it that the address is a duplicate. Only after this process occurs, can the interface use the newly configured address. If the interface receives a message that the newly configured address is a duplicate, it cannot use the address.

Until the Duplicate Address Detection (DAD) process completes, the new address is considered tentative, and will be shown as such in any display output. If the address is a duplicate, it will also be labeled as such, and must be reconfigured. On an active interface, the DAD process should occur so quickly that you would not see the address labeled as tentative. However, if you are configuring an interface before enabling it, and you display the configuration, you will see that the address is currently tentative. As soon as you enable the interface, the address should be ready to use, or labeled as duplicate and must be reconfigured.

See RFC 2462, *IPv6 Stateless Address Autoconfiguration*, for more details.

DAD Overview

When enabled on a user VR or *VR-Default*, the Duplicate Address Detection (DAD) feature runs when an IP interface is initialized or when a CLI command initiates a DAD check. The DAD check tests IP addresses by sending a neighbor solicitation to each IP address it checks. If another device replies to the neighbor solicitation, a duplicate IP address is detected.

If a duplicate address is detected, the IP interface remains or becomes inactive, and a warning message is logged. If no duplicate address is detected, the IP interface transitions to or remains in the active state. The switch does not automatically repeat the DAD check after the first check is complete. To manually run a DAD test on an interface or IP address, enter the `run ipv6 dad` command.

Because the automatic DAD check only runs when an interface is initialized, the switch does not detect a duplicate IP address if that address becomes active after the switch interface is initialized. However, if the switch is rebooted or the interface is brought down and then up, the automatic DAD check runs and sets to inactive any interface for which a duplicate IP address is detected.

To successfully test an IPv6 interface, at least one port in the host VLAN must be in the *Up* state. If all ports in the host VLAN are *Down*, the DAD check does not run. If a port is later added to the host VLAN, or if a port in the host VLAN transitions to *Up* after the DAD check at initialization is complete, a duplicate IP address can be detected and logged, but the IP interface on the host VLAN remains active.

Configuring DAD

To enable or disable the DAD feature and configure feature operation, use the following command:

```
configure ipv6 dad [off | on | {on} attempts <max_solicitations>] {{vr} <vr_name> | vr all}
```



NOTE

For IPv6 interfaces, the DAD feature is automatically enabled on all platforms that support the Edge, Advanced Edge, and Core licenses.

Running a DAD Test

To initiate a DAD test, use the following command:

```
run ipv6 dad [{vlan} <vlan_name> | {{vr} <vr_name>} <ipaddress>]
```

Displaying DAD Configuration and Statistics

To display DAD configuration and statistics information, use the following command:

```
show ipv6 dad {{{vr} <vr_name> | vr all | {vlan} <vlan_name> | {tunnel}
<tunnel_name> {tentative | valid | duplicate} | {{vr} <vr_name>} <ipaddress>}}
{detail}
```

Clearing the DAD Counters

To clear the DAD feature statistics counters, use the following command:

```
clear ipv6 dad {{vr} <vr_name> <ipaddress>} | vr all | {vlan} <vlan_name>} {counters}
```

Populating the Routing Table

The switch maintains an IP routing table for both network routes and host routes. The table is populated from the following sources:

- Dynamically, by way of routing protocol packets or by Internet Control Message Protocol (ICMP) redirects exchanged with other routers
- Statically, by way of routes entered by the administrator:
 - Default routes, configured by the administrator
 - Locally, by way of interface addresses assigned to the system
 - By other static routes, as configured by the administrator

Once routes are populated using the above method, IPv6 forwarding needs to be enabled on the VLAN using the following command:

```
enable ipforwarding ipv6 {vlan <vlan_name> | tunnel <tunnel-name> | vr <vr_name>}
```



NOTE

If you define a default route and subsequently delete the VLAN on the subnet associated with the default route, the invalid default route entry remains. You must manually delete the configured default route.

The following sections provide additional information about the routing table entries:

- [Dynamic Routes on page 1258](#)
- [Static Routes on page 1259](#)
- [Multiple Routes on page 1259](#)
- [Relative Route Priorities on page 1260](#)

Dynamic Routes

Dynamic routes are typically learned by way of RIPng, OSPFv3, or IS-IS, and routers that use these protocols use *advertisements* to exchange information in their routing tables. Using dynamic routes, the routing table contains only networks that are reachable.

Dynamic routes are aged out of the table when an update for the network is not received for a period of time, as determined by the routing protocol. For details on the configuration and behavior of IPv6 dynamic routes, please refer to the specific Chapters on RIPng, OSPFv3, and IS-IS in this guide.

Static Routes

Static routes are manually entered into the routing table. Static routes are used to reach networks not advertised by routers. Static IPv6 routes can be created using the following command:

```
configure iproute add <ipv6Netmask> [<ipv6Gateway> | <ipv6ScopedGateway>] {<metric>}
{vr <vrname>} {multicast | multicast-only | unicast | unicast-only}
```

You can configure IPv6 default and blackhole routes. Traffic to blackhole routes is silently dropped.

The IPv6 gateway can be a global address or a scoped link-local address of an adjacent router.

You can create static routes, for security reasons, to control which routes you want advertised by the router. If you want all static routes to be advertised, configure static routes using one of the following commands:

```
enable ripng export [direct | ospfv3 | ospfv3-extern1 | ospfv3-extern2 | ospfv3-inter
| ospfv3-intra | static | isis | isis-level-1 | isis-level-1-external | isis-level-2 |
isis-level-2-external | bgp] [cost <number> {tag <number>} | policy <policy-name>]
or
disable ripng export [direct | ospfv3 | ospfv3-extern1 | ospfv3-extern2 | ospfv3-inter
| ospfv3-intra | static | isis | isis-level-1 | isis-level-1-external | isis-level-2 |
isis-level-2-external | bgp]
```

```
enable ospfv3 {domain <domainName>} export [direct | ripng | static | isis | isis-
level-1 | isis-level-1-external | isis-level-2 | isis-level-2-external | bgp]
[cost <cost> type [ase-type-1 | ase-type-2] | <policy-map>]
or
disable ospfv3 {domain <domainName>} export [direct | ripng | static | isis | isis-
level-1 | isis-level-1-external | isis-level-2 | isis-level-2-external | bgp]
```

The default setting is disabled. Static routes are never aged out of the routing table.

A static route's nexthop (gateway) must be associated with a valid IP subnet. An IP subnet is associated with a single VLAN by its IP address and subnet mask. If the VLAN is subsequently deleted, the static route entries using that subnet must be deleted manually.

The IPv6 routes can be viewed using the following command:

```
show iproute ipv6 {priority | vlan <vlan_name> | tunnel <tunnel-name> | <ipv6Netmask>
| summary {multicast | unicast}} {vr <vrname>}}
```

To view the IPv6 routes based on the type of the route, use the command:

```
show iproute ipv6 origin [direct | static | blackhole | ripng | ospfv3 | ospfv3-intra
| ospfv3-inter | ospfv3-extern1 | ospfv3-extern2 | isis | isis-level-1 | isis-level-2 |
isis-level-1-external | isis-level-2-external] {vr <vrname>}}
```

Multiple Routes

When there are multiple, conflicting choices of a route to a particular destination, the router picks the route with the longest matching network mask. If these are still equal, the router picks the route using the following default criteria (in the order specified):

- Directly attached network interfaces
- Static routes
- ICMP redirects

- Dynamic routes
- Directly attached network interfaces that are not active.

**NOTE**

If you define multiple default routes, the route that has the lowest metric is used. If multiple default routes have the same lowest metric, the system picks one of the routes.

The criteria for choosing from multiple routes with the longest matching network mask is set by choosing the relative route priorities.

Relative Route Priorities

Table 127 lists the relative priorities assigned to routes depending on the learned source of the route.

**NOTE**

Although these priorities can be changed, do not attempt any manipulation unless you are expertly familiar with the possible consequences.

Table 127: Relative Route Priorities

Route Origin	Priority
Direct	10
BlackHole	50
Static	1100
ICMP	1200
OSPF3Intra	2200
OSPF3Inter	2300
IS-IS	2350
IS-IS L1	2360
IS-IS L2	2370
RIPng	2400
OSPFv3 AExt	3100
OSPFv3 Extern1	3200
OSPFv3 Extern2	3300
IS-IS L1Ext	3400
IS-IS L2Ext	3500

To change the relative route priority, use the following command:

```
configure ipv6 priority [ripng | blackhole | icmp | static | ospfv3-intra |
ospfv3-inter | ospfv3-as-external | ospfv3-extern1 | ospfv3-extern2 | isis-level-1 |
isis-level-2 | isis-level-1-external | isis-level-2-external] <priority> {vr <vrname>}
```

Unique Local Address (ULA) for IPv6

RFC 4193 defines a globally unique address that is used for local communications. For instance, they are routable within a specified site or between sites. These ULAs are similar to private addresses in IPv4 (RFC 1918).

Of the 128 bits available in IPv6 address, the last 64-bits are used as the interface ID. The remaining 64 bits are used as follows:

- First 8 bits are used to define the known prefix FC00::/7 or FD00::/7
- 40 bits - global ID - Generated using a random algorithm specified in the RFC 4193. EXOS expects the operator to specify the 40-bit Global ID as ULA address management becomes easier, especially a mult-vendor environment.
- 16 bits - Used to create subnets within the site.

ULA prefixes should not be accepted by the border routers. Additionally, ULA prefixes should not be advertised by the border routers. In ExtremeXOS, for BGP and OSPFv3, you must specify the policies to filter ULA prefixes.

There are no new CLI commands introduced to configure ULAs in EXOS. You can use the following existing command to configure a ULA:

```
configure {vlan} <vlan_name> ipaddress [<ipaddress> {<ipNetmask>} |
ipv6-link-local | {eui64} <ipv6_address_mask>]
```

Here is an example of the command:

```
configure vlan v1 ipaddress fd21:0941:2c55::/48
```

The scope of ULA is global by default in RFC 4193. All applications treat these addresses in a similar manner as any other type of global IPv6 unicast addresses.

Managing IPv6 Unicast Routing

The following sections describe IP unicast routing management tasks:

- [Configuring Basic IP Unicast Routing on page 1261](#)
- [See RFC 2462, IPv6 Stateless Address Autoconfiguration, for more details. on page 1257](#)
- [Managing Neighbor Discovery on page 1252](#)
- [Managing Router Discovery on page 1262](#)
- [Managing Tunnels on page 1263](#)
- [Verifying the IP Unicast Routing Configuration on page 1264](#)
- [Managing IPv6 Routes and Hosts in External Tables on page 1264](#)

Configuring Basic IP Unicast Routing

To configure basic IP unicast routing, do the following:

- 1 Create and configure two or more VLANs.
- 2 Assign each VLAN that will be using routing an IP address using the following command:

```
configure {vlan} <vlan_name> ipaddress [<ipaddress> {<ipNetmask>} | ipv6-link-
local | {eui64} <ipv6_address_mask>]
```

Ensure that each VLAN has a unique IP address.

3 Configure a static route using the following command:

```
configure iproute add <ipv6Netmask> [<ipv6Gateway> | <ipv6ScopedGateway>]
{<metric>} {vr <vrname>} {multicast | multicast-only | unicast | unicast-only}
```

or

Configure a default route using the following command:

```
configure iproute add default [<ipv6Gateway> | <ipv6ScopedGateway>] {metric} {vr
<vrname>} {multicast-only | unicast-only}
```

Default routes are used when the router has no other dynamic or static route to the requested destination.

4 Turn on IP routing for one or all VLANs using the following command:

```
enable ipforwarding ipv6 {vlan <vlan_name> | tunnel <tunnel-name> | vr <vr_name>}
```

5 Configure the routing protocol, if required. For a simple network using RIPng, the default configuration might be acceptable.**6** Turn on RIPng or OSPFv3 using one of the following commands:

```
enable ripng
enable ospfv3 {domain <domainName>}
```

Managing Router Discovery

The following sections describe tasks for managing router discovery:

- [Enabling and Disabling Router Discovery on page 1262](#)
- [Adding and Deleting Prefixes for Router Discovery on page 1262](#)
- [Configuring Router Discovery Settings on page 1262](#)
- [Displaying Router Discovery Configuration Settings on page 1263](#)

Enabling and Disabling Router Discovery

To enable or disable router discovery on a VLAN, use the following commands:

```
enable router-discovery {ipv6} vlan <vlan_name>
disable router-discovery {ipv6} vlan <vlan_name>
```

Adding and Deleting Prefixes for Router Discovery

To add or delete prefixes for advertisement by router discovery, use the following commands:

```
configure vlan <vlan_name> router-discovery {ipv6} add prefix <prefix>
configure vlan <vlan_name> router-discovery {ipv6} delete prefix [<prefix> | all]
```

Configuring Router Discovery Settings

To configure the router discovery settings, use the following commands:

```
configure vlan <vlan_name> router-discovery {ipv6} default-lifetime <defaultlifetime>
configure vlan <vlan_name> router-discovery {ipv6} link-mtu <linkmtu>
configure vlan <vlan_name> router-discovery {ipv6} managed-config-flag <on_off>
configure vlan <vlan_name> router-discovery {ipv6} max-interval <maxinterval>
configure vlan <vlan_name> router-discovery {ipv6} min-interval <mininterval>
configure vlan <vlan_name> router-discovery {ipv6} other-config-flag <on_off>
```

```
configure vlan <vlan_name> router-discovery {ipv6} reachable-time <reachablename>
configure vlan <vlan_name> router-discovery {ipv6} retransmit-time <retransmittime>
configure vlan <vlan_name> router-discovery {ipv6} set prefix <prefix> [autonomous-
flag <auto_on_off> | onlink-flag <onlink_on_off> | preferred-lifetime <preflife>
| valid-lifetime <validlife>]
```

To reset all router discovery settings to their default values, enter the following command:

```
unconfigure vlan <vlan_name> router-discovery {ipv6}
```

To reset an individual router discovery setting to its default value, enter one of the following commands:

```
unconfigure vlan <vlan_name> router-discovery {ipv6} default-lifetime
unconfigure vlan <vlan_name> router-discovery {ipv6} hop-limit
unconfigure vlan <vlan_name> router-discovery {ipv6} link-mtu
unconfigure vlan <vlan_name> router-discovery {ipv6} managed-config-flag
unconfigure vlan <vlan_name> router-discovery {ipv6} max-interval
unconfigure vlan <vlan_name> router-discovery {ipv6} min-interval
unconfigure vlan <vlan_name> router-discovery {ipv6} other-config-flag
unconfigure vlan <vlan_name> router-discovery {ipv6} reachable-time
unconfigure vlan <vlan_name> router-discovery {ipv6} retransmit-time
```

Displaying Router Discovery Configuration Settings

To display router discovery settings, use the following command:

```
show router-discovery {ipv6} {vlan <vlan_name>}
```

Managing Tunnels

IPv6-in-IPv4 and IPv6-to-IPv4 tunnels are introduced in “Tunnels” on page 1249. The following sections describe how to manage tunnels:

- [Creating an IPv6-in-IPv4 Tunnel on page 1263](#)
- [Creating an IPv6-to-IPv4 Tunnel on page 1264](#)
- [Deleting a Tunnel on page 1264](#)
- [Configuring an IPv6 Address for a Tunnel on page 1264](#)
- [Displaying Tunnel Information on page 1264](#)

Creating an IPv6-in-IPv4 Tunnel

To create an IPv6-in-IPv4 tunnel, use the following command:

```
create tunnel <tunnel_name> ipv6-in-ipv4 destination <destination-address> source
<source-address>
```

The `source-address` refers to an existing address in the switch, and the `destination-address` is a remote destination accessible from the switch. A maximum of 255 IPv6-in-IPv4 tunnels can be configured.

Creating an IPv6-to-IPv4 Tunnel

A 6to4 tunnel connects one IPv6 region with multiple IPv6 regions. Only one 6to4 tunnel can be configured on a single router.

To create an IPv6-to-IPv4 tunnel, use the following command:

```
create tunnel <tunnel_name> 6to4 source <source-address>
```

The `source-address` is an existing address in the switch.

Deleting a Tunnel

To delete a tunnel, use the following command:

```
delete tunnel <tunnel_name>
```

Configuring an IPv6 Address for a Tunnel

To configure or unconfigure IPv6 addresses for the tunnels, use the following commands:

```
configure tunnel <tunnel_name> ipaddress [ipv6-link-local | {eui64}  
<ipv6_address_mask> ]
```

```
unconfigure tunnel <tunnel_name> ipaddress <ipv6_address_mask>
```

Displaying Tunnel Information

To display tunnel information, use the following command:

```
show [{tunnel} {<tunnel_name>}]
```

Verifying the IP Unicast Routing Configuration

To display the currently configured routes, which includes how each route was learned, use the following command:

```
show iproute ipv6
```

Additional verification commands include:

- `show neighbor-discovery cache ipv6`—Displays the neighbor discovery cache of the system.
- `show ipconfig ipv6`—Displays configuration information for one or more VLANs.
- `show ipstats ipv6`—Displays the IPv6 statistics for the switch or for the specified VLANs.

Managing IPv6 Routes and Hosts in External Tables

When external LPM tables are supported and configured on a switch, the configuration setting applies only to the external LPM tables. You can configure the external LPM to contain both IPv4 and, or, IPv6 routes. Internal LPM tables only store IPv4 routes.

The `configure forwarding external-tables` command using the `ipv6` and `ipv4-and-ipv6` variables supports larger IPv6 route and host scaling in external LPM tables.

When an external LPM table is configured for `l3-only ipv6`, no IPv6 routes or IPv6 hosts are configured in any of the internal hardware tables. This provides the highest IPv6 scale, and avoids contention with IP Multicast in the L3 Hash hardware table.

IPv6 hardware and slowpath forwarding are supported on user-created Virtual Routers, and IPv6 tunnels are only supported on VR-Default.

The size of the internal LPM tables, and the size of the L3 Hash and Next Hop tables are fixed. For specific information on hardware capacity, refer to [Table 124](#), [Table 125](#), and [Table 126](#) in [Chapter 31, “IPv4 Unicast Routing,”](#).



NOTE

If you require a large number of IPv6 routes, you should use only xl-series modules, or a Summit X480 standalone, or a SummitStack comprised only of the X480. SummitStacks, or a BD8800 containing a mix of high- and low-capability hardware (slots without External TCAM) does not support more than 100,000 IPv6 routes present.

Configuring Route Compression

ExtremeXOS supports route optimization via route compression to reduce the number of routes to be installed in hardware. This helps with route optimization and scaling. This feature allows you to install only less specific routes in the table when overlapping routes with the same nexthop exist. For detailed information about route compression, see [“Hardware Routing Table Management” on page 1208](#).

To enable this feature, use the command:

```
enable iproute ipv6 compression {vr <vrname>}
```

To disable this feature, use the command:

```
disable iproute ipv6 compression {vr <vrname>}
```

Hardware Forwarding Behavior

[Table 128](#) shows the Extreme switch platforms and the ExtremeXOS software versions that provide hardware forwarding support for IPv6 unicast features.

Table 128: IPv6 Unicast Features

Switch Model	ExtremeXOS Release	Features
Summit X250e	ExtremeXOS 12.0 and later	IPv6 Unicast forwarding IPv6 tunneling
Summit X450 a- and e-series	ExtremeXOS 11.5 and later	IPv6 Unicast forwarding
Summit X450 a- and e-series	ExtremeXOS 12.0 and later	IPv6 tunneling
Summit X460 series	ExtremeXOS 12.5 and later	IPv6 Unicast forwarding IPv6 tunneling
Summit X480 series	ExtremeXOS 12.4 and later	IPv6 Unicast forwarding IPv6 tunneling

Table 128: IPv6 Unicast Features (Continued)

Switch Model	ExtremeXOS Release	Features
Summit X650 series	ExtremeXOS 12.2 and later	IPv6 Unicast forwarding IPv6 tunneling
Summit X670 series	ExtremeXOS 12.6 and later	IPv6 Unicast forwarding IPv6 tunneling
BlackDiamond 8000 e-series	ExtremeXOS 11.6 and later	IPv6 Unicast forwarding
BlackDiamond 8000 e-series	ExtremeXOS 12.0 and later	IPv6 tunneling
BlackDiamond 8000 c-series	ExtremeXOS 12.1 and later	IPv6 Unicast forwarding IPv6 tunneling
BlackDiamond 8000 xl-series	ExtremeXOS 12.4 and later	IPv6 Unicast forwarding IPv6 tunneling
BlackDiamond 8000 xm-series	ExtremeXOS 12.6 and later	IPv6 Unicast forwarding IPv6 tunneling
BlackDiamond X8 series	ExtremeXOS 15.1 and later	IPv6 Unicast forwarding IPv6 tunneling

Hardware Forwarding Limitations

Summit family switches, BlackDiamond 8000 series modules, and BlackDiamond X8 series modules can use hardware forwarding when the route mask is 64 bits or less. If the route mask is greater than 64 bits, limitations apply based on the hardware platform.

BlackDiamond 8000 e-series modules, BlackDiamond 8800 c-series modules, and Summit X250e, X440, X450a, X450e, and X460 switches support hardware forwarding for up to 256 routes with masks greater than 64 bits. This support was added in ExtremeXOS Release 12.4 by using some of the slices previously used for ACL support to create a Greater Than 64 Bit (GT64B) table. The GT64B table stores only those routes with a mask greater than 64 bits. When IPv6 forwarding is enabled, the switch behavior is as follows:

- Fewer slices are available for ACLs. The GT64B table consumes 1 slice on BlackDiamond 8800 c-series modules and Summit X440, and 2 slices on BlackDiamond 8000 a- and e-series modules and Summit X250e, X450a, X450e, and X460 switches.
To use the GT64B table on X440, one ACL slice must be free. Use `show access-list usage acl-slice` to check if any slice is unused. If no slice is available, consider disabling a feature that is consuming ACL slices if that feature is not required. Features that are enabled by default such as IGMP Snooping or MLD Snooping can be disabled to free up ACL resources if not required.
- Table-full messages appear when there is no more space in the GT64B table.
- If an eligible route cannot be added to the GT64B table (because the table is full), there is no guarantee that traffic for that route will be properly routed.
- If enabled, route compression for IPv6 can make room for additional routes by reducing the number of entries in the GT64B table.
- When an IPv6 address with a mask greater than 64 bits is configured on a VLAN or tunnel, that address is automatically added to the GT64B table.
- BlackDiamond 8800 c-series modules do not support hardware forwarding for routes with masks greater than 64 bits on user virtual routers.

BlackDiamond 8900 xl-series modules, and Summit X480 switches support hardware forwarding for up to 245,760 routes with masks greater than 64 bits, depending on the configured setting for external-tables.

BlackDiamond 8900 c- and xm-series modules, and Summit X480, X650, and X670 switches support hardware forwarding for up to 256 routes with masks greater than 64 bits. This support was added in ExtremeXOS Release 12.4 by using a hardware table designed for this purpose. When IPv6 forwarding is enabled, the switch behavior is as follows:

- If no space is available in the hardware table, there is no guarantee that traffic for that route will be properly routed.
- If enabled, route compression for IPv6 can make room for additional routes by reducing the number of entries in the hardware table.
- When an IPv6 address with a mask greater than 64 bits is configured on a VLAN or tunnel, that address is automatically added to the hardware table.

Hardware Tunnel Support

The platforms and software versions that provide hardware forwarding support for IPv6 traffic for both IPv6-in-IPv4 and 6to4 tunnels for various platforms are shown in [Table 128](#). In all the other platforms, tunnel traffic is forwarded in software and the statistics can be viewed from the `show ipstats ipv6` command.



NOTE

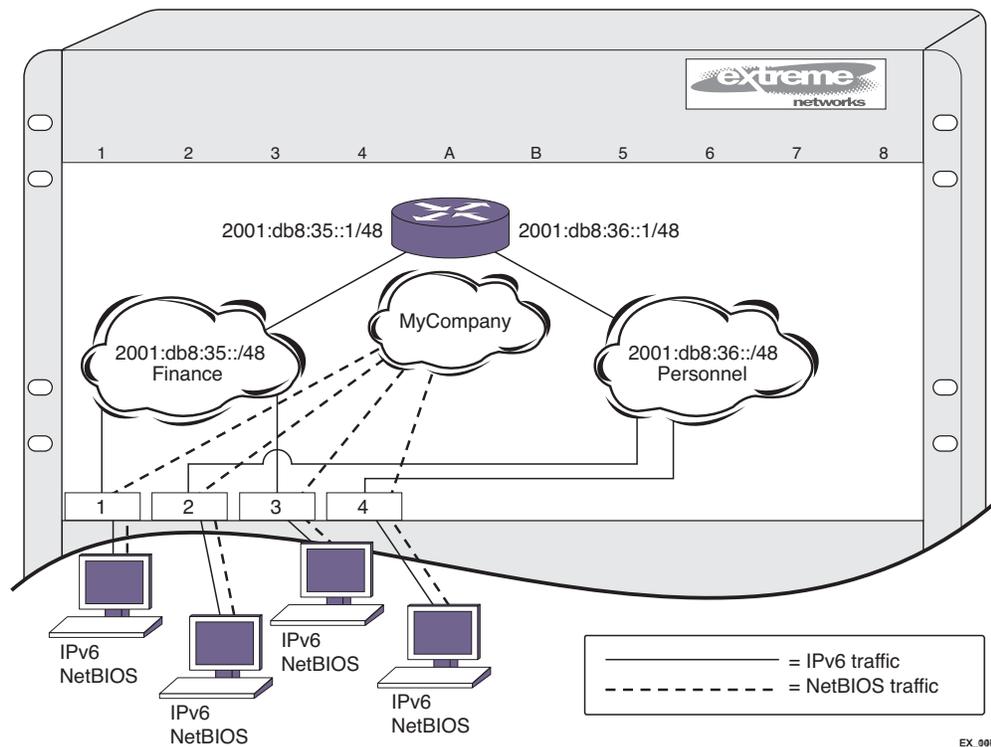
The MTU for IPv6 Tunnels is set to 1480 bytes, and is not user-configurable. Configuring jumbo frames has no effect on the MTU size for IPv6 tunnels.

Routing Configuration Example

[Figure 198](#) illustrates a BlackDiamond switch that has three VLANs defined as follows:

- *Finance*
 - Protocol-sensitive VLAN using IPv6 protocol
 - All ports on slots 1 and 3 have been assigned.
 - IP address `2001:db8:35::1/48`.
- *Personnel*
 - Protocol-sensitive VLAN using the IPv6 protocol.
 - All ports on slots 2 and 4 have been assigned.
 - IP address `2001:db8:36::1/48`.
- *MyCompany*
 - Port-based VLAN.
 - All ports on slots 1 through 4 have been assigned.

Figure 198: IPv6 Unicast Routing Configuration Example



The stations connected to the system generate a combination of IPv6 traffic and NetBIOS traffic. The IPv6 traffic is filtered by the protocol-sensitive VLANs. All other traffic is directed to the VLAN *MyCompany*.

In this configuration, all IPv6 traffic from stations connected to slots 1 and 3 have access to the router by way of the VLAN *Finance*. Ports on slots 2 and 4 reach the router by way of the VLAN *Personnel*. All other traffic (NetBIOS) is part of the VLAN *MyCompany*.

The example is configured as follows:

```
create vlan Finance
create vlan Personnel
create vlan MyCompany

configure Finance protocol ipv6
configure Personnel protocol ipv6

configure Finance add port 1:*,3:*
configure Personnel add port 2:*,4:*
configure MyCompany add port all

configure Finance ipaddress 2001:db8:35::1/48
configure Personnel ipaddress 2001:db8:36::1/48
configure ripng add vlan Finance
configure ripng add vlan Personnel

enable ipforwarding ipv6
enable ripng
```

Tunnel Configuration Examples

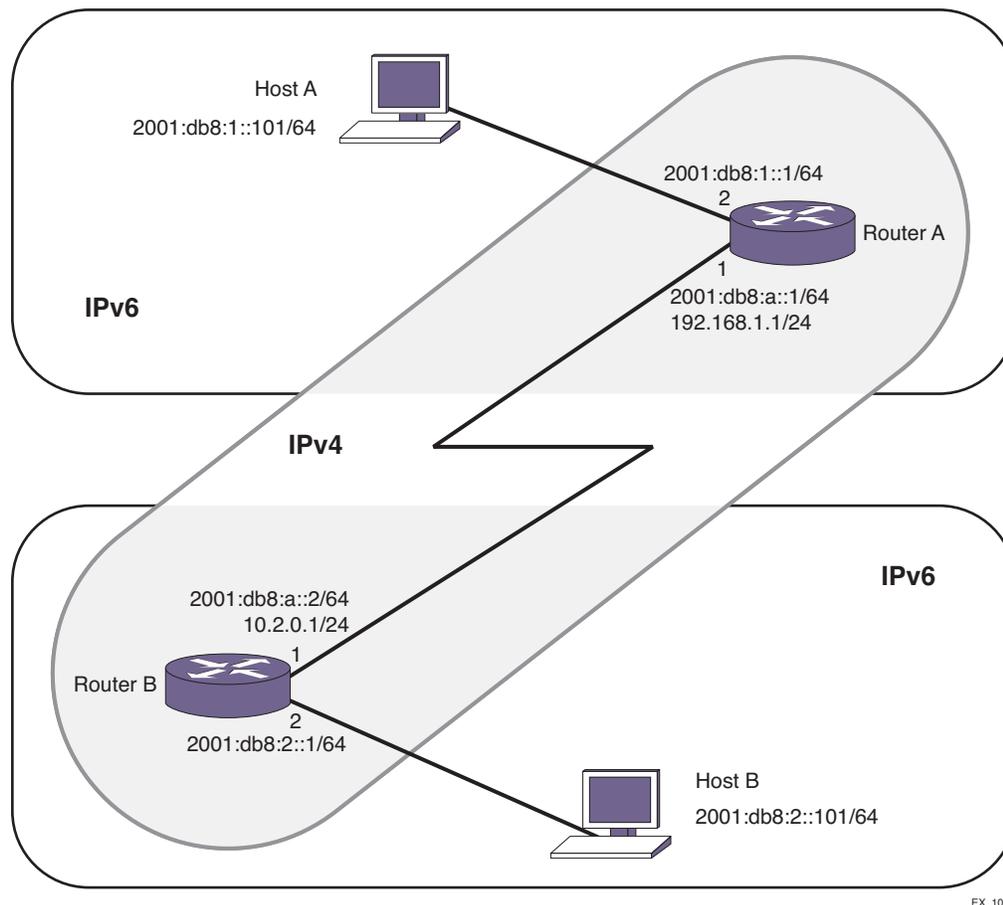
This section provides the following examples:

- [6in4 Tunnel Configuration Example on page 1269](#)
- [6to4 Tunnel Configuration Example on page 1271](#)

6in4 Tunnel Configuration Example

Figure 199 illustrates a 6in4 tunnel configured between two IPv6 regions across an IPv4 region.

Figure 199: 6in4 Tunnel Example



In Figure 199, Router A has an interface to an IPv4 region with the address 192.168.1.1 (for this example we are using private IPv4 addresses, but to tunnel across the Internet, you would use a public address). Router B has an IPv4 interface of 10.2.0.1. The IPv4 interface must be created before the tunnel is configured and cannot be deleted until the tunnel is deleted.

This example has one subnet in each IPv6 region, 2001:db8:1::/64 for Router A and 2001:db8:2::/64 for Router B. Hosts A and B are configured to use IPv6 addresses 2001:db8:1::101 and 2001:db8:2::101 respectively.

For traffic to move from one region to the other, there must be a route. In this example, a static route is created, but you could enable RIPng or OSPFv3 on the tunnel interface.

In this example, we assume that the IPv4 network can route from Router A to Router B (in other words, some IPv4 routing protocol is running on the public-ipv4 interfaces). For platforms on which hardware based tunneling is supported (See [Table 128 on page 1265](#)), IPv4 forwarding needs to be enabled on the tunnel source VLAN. However, in platforms on which IPv6-in-IPv4 tunnels are supported in software only, you do not need to enable IPv4 forwarding on the public interfaces in this example unless you are also routing IPv4 traffic on them (in this example, it is assumed you are running no IPv4 traffic inside your respective IPv6 networks, although you could).

When Host A needs to send a packet to 2001:db8:2::101 (Host B), it forwards it to Router A. Router A receives an IPv6 packet from the IPv6 source address 2001:db8:1::101 to the destination 2001:db8:2::101. Router A has the static route, for the route 2001:db8:2::/64 with next hop 2001:db8:a::2 (Router B) through the tunnel interface. So Router A encapsulates the IPv6 packet inside an IPv4 header with the source address 192.168.1.1 and destination address 10.2.0.1. The encapsulated IPv6 packet passes through the IPv4 network and reaches the other end of the tunnel—Router B. Router B decapsulates the packet and removes the IPv4 header. Router B then forwards the IPv6 packet to the destination host—Host B.

**NOTE**

Each IPv6 packet is encapsulated inside an IPv4 header (20 bytes) before it is forwarded via a IPv6-in-IPv4 tunnel. For example, a 66-byte packet from Host A will be encapsulated and forwarded as a 86-byte packet by Router A.

Router A

```
configure vlan default delete port all
create vlan public-ipv4
configure vlan public-ipv4 add port 1 untagged
configure vlan public-ipv4 ipaddress 192.168.1.1/24
create tunnel public6in4 ipv6-in-ipv4 destination 10.2.0.1 source 192.168.1.1
configure tunnel public6in4 ipaddress 2001:db8:a::1/64
enable ipforwarding ipv6 public6in4
create vlan private-ipv6
configure vlan private-ipv6 add port 2 untagged
configure vlan private-ipv6 ipaddress 2001:db8:1::1/64
enable ipforwarding ipv6 private-ipv6
configure iproute add 2001:db8:2::/64 2001:db8:a::2
enable ipforwarding public-ipv4
```

Router B

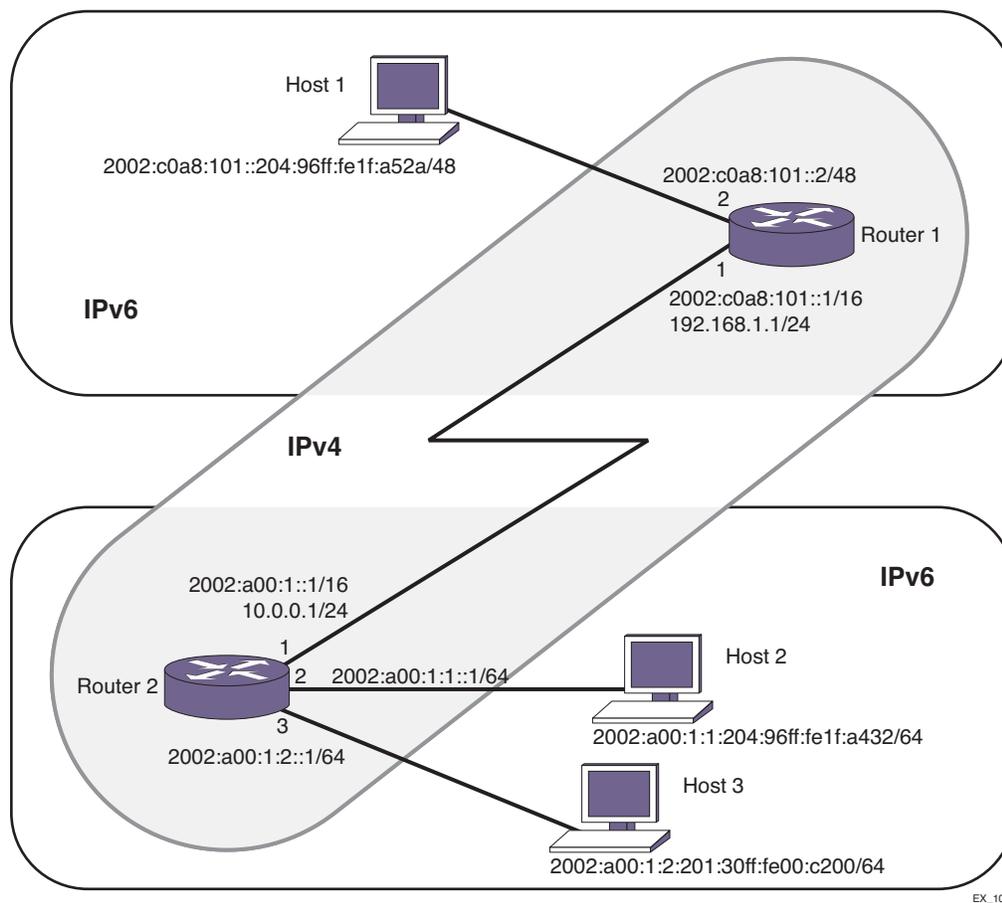
```
configure vlan default delete port all
create vlan public-ipv4
configure vlan public-ipv4 add port 1 untagged
configure vlan public-ipv4 ipaddress 10.2.0.1/24
create tunnel public6in4 ipv6-in-ipv4 destination 192.168.1.1 source 10.2.0.1
configure tunnel public6in4 ipaddress 2001:db8:a::2/64
enable ipforwarding ipv6 public6in4
create vlan private-ipv6
configure vlan private-ipv6 add port 2 untagged
configure vlan private-ipv6 ipaddress 2001:db8:2::1/64
enable ipforwarding ipv6 private-ipv6
```

```
configure iproute add 2001:db8:1::/64 2001:db8:a::1
enable ipforwarding public-ipv4
```

6to4 Tunnel Configuration Example

Figure 200 illustrates a 6to4 tunnel configured between two IPv6 regions across an IPv4 region.

Figure 200: 6to4 Tunnel Configuration Example



In Figure 200, Router 1 has an interface to an IPv4 region with the address 192.168.1.1 (for this example we are using private IPv4 addresses, but to tunnel across the Internet, you would use a public address). Router 2 has an IPv4 interface of 10.0.0.1. The IPv4 interface must be created before the tunnel is configured and cannot be deleted until the tunnel is deleted.

The IPv6 endpoints of 6to4 tunnels must follow the standard 6to4 address requirement. The address must be of the form `2002:<IPv4_source_endpoint>::/16`, where `<IPv4_source_endpoint>` is replaced by the IPv4 source address of the endpoint, in hexadecimal, colon separated form. For example, for a tunnel endpoint located at IPv4 address 10.20.30.40, the tunnel address would be `2002:0a14:1e28::/16`. In hex, 10 is 0a, 20 is 14, 30 is 1e and 40 is 28.

This example shows a simple setup on the Router 1 side (one big /48 IPv6 routing domain with no subnets), and a slightly more complex setup on the Router 2 side (two subnets :0001: and :0002: that are /64 in length). Hosts 1, 2, and 3 will communicate using their global 2002: addresses.

The hosts in this example configure themselves using the EUI64 interface identifier derived from their MAC addresses. Refer to your host OS vendor's documentation for configuring IPv6 addresses and routes.

In this example, we assume that the IPv4 network can route from Router 1 to Router 2 (in other words, some IPv4 routing protocol is running on the public-ipv4 interfaces). However, you do not need to enable IPv4 forwarding on the public interfaces in this example unless you are also routing IPv4 traffic on them (in this example, it is assumed you are running no IPv4 traffic inside your respective IPv6 networks, although you could).

Router 1

```
configure vlan default delete port all
create vlan public-ipv4
configure vlan public-ipv4 add port 1 untagged
configure vlan public-ipv4 ipaddress 192.168.1.1/24
create tunnel public6to4 6to4 source 192.168.1.1
configure tunnel public6to4 ipaddress 2002:c0a8:0101::1/16
enable ipforwarding ipv6 public6to4
create vlan private-ipv6
configure vlan private-ipv6 add port 2 untagged
configure vlan private-ipv6 ipaddress 2002:c0a8:0101::2/48
enable ipforwarding ipv6 private-ipv6
```

Router 2

```
configure vlan default delete port all
create vlan public-ipv4
configure vlan public-ipv4 add port 1 untagged
configure vlan public-ipv4 ipaddress 10.0.0.1/24
create tunnel public6to4 6to4 source 10.0.0.1
configure tunnel public6to4 ipaddress 2002:0a00:0001::1/16
enable ipforwarding ipv6 public6to4
create vlan private-ipv6-sub1
configure vlan private-ipv6-sub1 add port 2 untagged
configure vlan private-ipv6-sub1 ipaddress 2002:0a00:0001:0001::1/64
enable ipforwarding ipv6 private-ipv6-sub1
create vlan private-ipv6-sub2
configure vlan private-ipv6-sub2 add port 3 untagged
configure vlan private-ipv6-sub2 ipaddress 2002:0a00:0001:0002::1/64
enable ipforwarding ipv6 private-ipv6-sub2
```

Host Configurations

The IPv6 addresses of these hosts are based on their MAC address-derived EUI64 interface identifiers and the address prefixes for their subnets. Each host must also have a static route configured on it for 6to4 addresses.

Host 1:

- MAC address—00:04:96:1F:A5:2A
- IPv6 address—2002:c0a8:0101::0204:96ff:fe1f:a52a/48
- Static route—destination 2002::/16, gateway 2002:c0a8:0101::2

Host 2:

- MAC address—00:04:96:1F:A4:32
- IP address—2002:0a00:0001:0001:0204:96ff:fe1f:a432/64
- Static route—destination 2002::/16, gateway 2002:0a00:0001:0001::1

Host 3:

- MAC address—00:01:30:00:C2:00
- IP address—2002:0a00:0001:0002:0201:30ff:fe00:c200/64
- Static route—destination 2002::/16, gateway 2002:0a00:0001:0002::1

33

CHAPTER

RIP

This chapter includes the following sections:

- [Overview on page 1275](#)
- [Overview of RIP on page 1276](#)
- [Route Redistribution on page 1278](#)
- [RIP Configuration Example on page 1279](#)

This chapter assumes that you are already familiar with IP unicast routing. If not, refer to the following publications for additional information:

- RFC 1058—*Routing Information Protocol (RIP)*
- RFC 1723—*RIP Version 2*
- *Interconnections: Bridges and Routers*
by Radia Perlman
ISBN 0-201-56332-0
Published by Addison-Wesley Publishing Company



NOTE

RIP is available on platforms with an Edge, Advanced Edge or Core license. See [Appendix A, "Feature License Requirements"](#) for specific information regarding RIP licensing

Overview

The switch supports the use of the following interior gateway protocols (IGPs):

- Routing Information Protocol (RIP)
- Open Shortest Path First (OSPF)
- Intermediate System-Intermediate System (IS-IS)

RIP is a distance-vector protocol, based on the Bellman-Ford (or distance-vector) algorithm. The distance-vector algorithm has been in use for many years and is widely deployed and understood.

OSPF and IS-IS are link-state protocols, based on the Dijkstra link-state algorithm. OSPF and IS-IS are newer IGPs and solve a number of problems associated with using RIP on today's complex networks.

**NOTE**

RIP can be enabled on a VLAN with either OSPF or IS-IS. OSPF and IS-IS cannot be enabled on the same VLAN.

RIP is described in this chapter; OSPF is described in [Chapter 35, “OSPF,”](#) and IS-IS is described in [Chapter 37, “IS-IS.”](#)

RIP Versus OSPF and IS-IS

The distinction between RIP and the OSPF and IS-IS link-state protocols lies in the fundamental differences between distance-vector protocols and link-state protocols. Using a distance-vector protocol, each router creates a unique routing table from summarized information obtained from neighboring routers. Using a link-state protocol, every router maintains an identical routing table created from information obtained from all routers in the autonomous system (AS). Each router builds a shortest path tree, using itself as the root. The link-state protocol ensures that updates sent to neighboring routers are acknowledged by the neighbors, verifying that all routers have a consistent network map.

Advantages of RIP, OSPF, and IS-IS

The biggest advantage of using RIP is that it is relatively simple to understand and to implement, and it has been the *de facto* routing standard for many years.

RIP has a number of limitations that can cause problems in large networks, including the following:

- A limit of 15 hops between the source and destination networks
- A large amount of bandwidth taken up by periodic broadcasts of the entire routing table
- Slow convergence
- Routing decisions based on hop count; no concept of link costs or delay
- Flat networks; no concept of areas or boundaries

OSPF and IS-IS offer many advantages over RIP, including the following:

- No limitation on hop count
- Route updates multicast only when changes occur
- Faster convergence
- Support for load balancing to multiple routers based on the actual cost of the link
- Support for hierarchical topologies where the network is divided into areas

The details of RIP are explained later in this chapter.

Overview of RIP

RIP is an IGP first used in computer routing in the Advanced Research Projects Agency Network (ARPAnet) as early as 1969. It is primarily intended for use in homogeneous networks of moderate size.

To determine the best path to a distant network, a router using RIP always selects the path that has the least number of hops. Each router that data must traverse is considered to be one hop.

Routing Table

The routing table in a router using RIP contains an entry for every known destination network. Each routing table entry contains the following information:

- IP address of the destination network
- Metric (hop count) to the destination network
- IP address of the next router
- Timer that tracks the amount of time since the entry was last updated

The router exchanges an update message with each neighbor every 30 seconds (default value), or when there is a change to the overall routed topology (also called *triggered updates*). If a router does not receive an update message from its neighbor within the route timeout period (180 seconds by default), the router assumes the connection between it and its neighbor is no longer available.

Split Horizon

Split horizon is a scheme for avoiding problems caused by including routes in updates sent to the router from which the route was learned. Split horizon omits routes learned from a neighbor in updates sent to that neighbor.

Poison Reverse

Like split horizon, poison reverse is a scheme for eliminating the possibility of loops in the routed topology. In this case, a router advertises a route over the same interface that supplied the route, but the route uses a hop count of 16, which defines that router as unreachable.

Triggered Updates

Triggered updates occur whenever a router changes the metric for a route. The router is required to send an update message immediately, even if it is not yet time for a regular update message to be sent. This generally results in faster convergence, but may also result in more RIP-related traffic.

Route Advertisement of VLANs

Virtual LANs (VLANs) that are configured with an IP address but are configured to not route IP or are not configured to run RIP, do not have their subnets advertised by RIP. RIP advertises *only* those VLANs that are configured with an IP address, are configured to route IP, and run RIP.

RIP Version 1 Versus RIP Version 2

A new version of RIP, called RIP version 2, expands the functionality of RIP version 1 to include the following:

- Variable-length subnet masks (VLSMs).
- Support for next-hop addresses, which allows for optimization of routes in certain environments.
- Multicasting.

RIP version 2 packets can be multicast instead of being broadcast, reducing the load on hosts that do not support routing protocols.

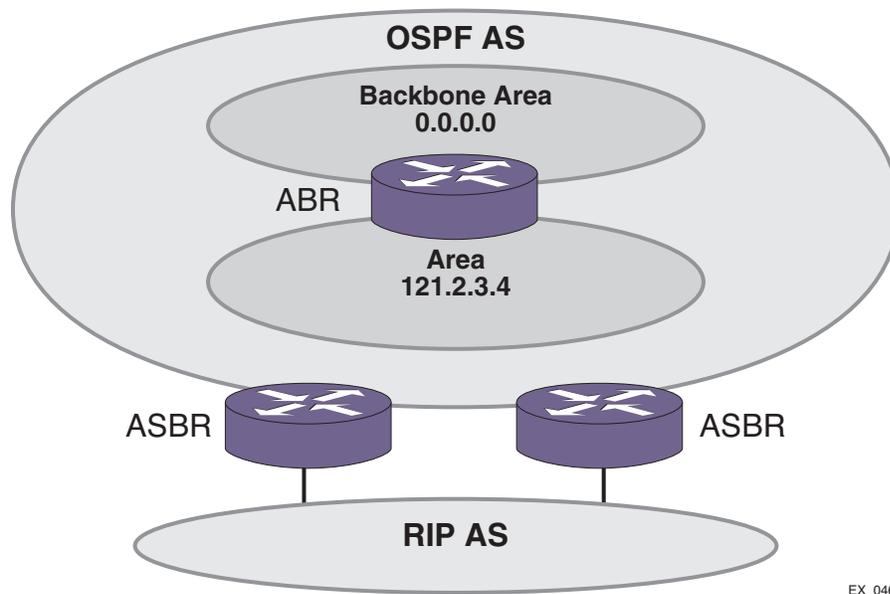
**NOTE**

If you are using RIP with supernetting/Classless Inter-Domain Routing (CIDR), you must use RIPv2 only.

Route Redistribution

More than one routing protocol can be enabled simultaneously on the switch. Route redistribution allows the switch to exchange routes, including static routes, between the routing protocols. [Figure 201](#) is an example of route redistribution between an OSPF AS and a RIP AS.

Figure 201: Route Redistribution



Configuring Route Redistribution

Exporting routes from one protocol to another and from that protocol to the first one are discrete configuration functions. For example, to run OSPF and RIP simultaneously, you must first configure both protocols and then verify the independent operation of each. Then you can configure the routes to export from OSPF to RIP and the routes to export from RIP to OSPF. Likewise, for any other combinations of protocols, you must separately configure each to export routes to the other.

Redistributing Routes into RIP

Enable or disable the exporting of static, direct, BGP-learned, and OSPF-learned routes into the RIP domain using the following commands:

```
enable rip export [bgp | direct | e-bgp | i-bgp | ospf | ospf-extern1 | ospf-extern2 |
ospf-inter | ospf-intra | static | isis | isis-level-1 | isis-level-1-external | isis-
level-2 | isis-level-2-external ] [cost <number> {tag <number>} | policy <policy-
name>]
```

```
disable rip export [bgp | direct | e-bgp | i-bgp | ospf | ospf-extern1 | ospf-extern2
| ospf-inter | ospf-intra | static | isis | isis-level-1 | isis-level-1-external |
isis-level-2 | isis-level-2-external ]
```

These commands enable or disable the exporting of static, direct, and OSPF-learned routes into the RIP domain. You can choose which types of OSPF routes are injected, or you can simply choose `ospf`, which will inject all learned OSPF routes regardless of type. The default setting is disabled.

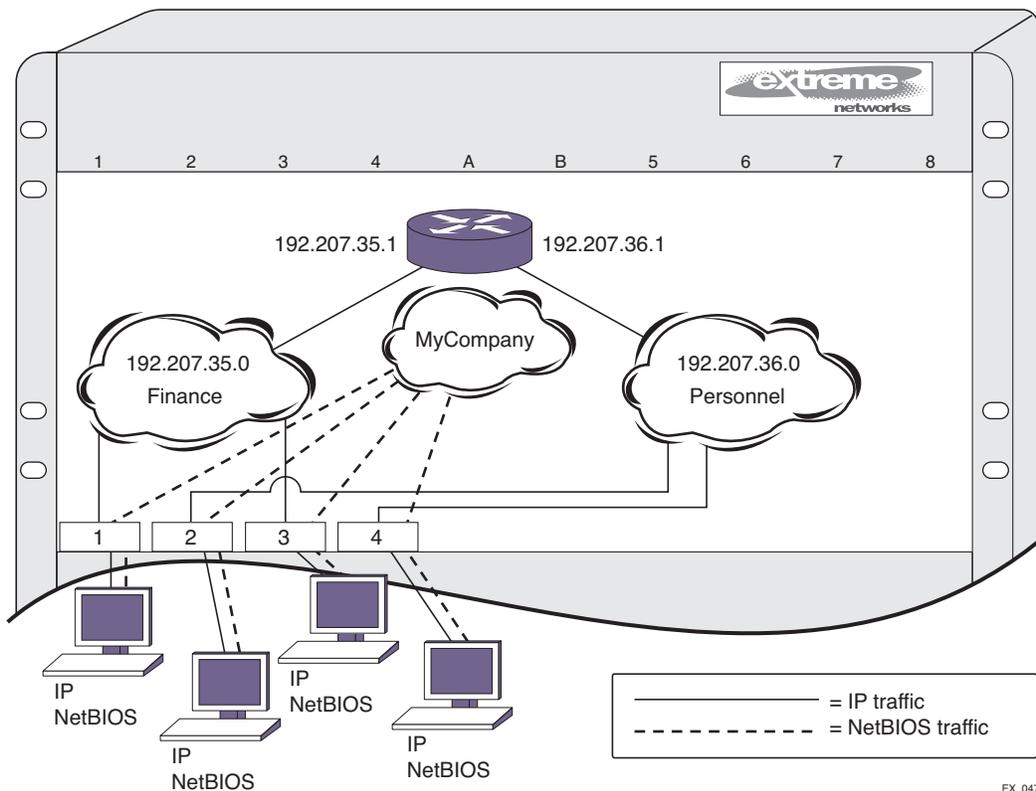
RIP Configuration Example

Figure 202 illustrates a BlackDiamond switch that has three VLANs defined as follows:

- *Finance*
 - Protocol-sensitive VLAN using the IP protocol.
 - All ports on slots 1 and 3 have been assigned.
 - IP address 192.207.35.1.
- *Personnel*
 - Protocol-sensitive VLAN using the IP protocol.
 - All ports on slots 2 and 4 have been assigned.
 - IP address 192.207.36.1.
- *MyCompany*
 - Port-based VLAN.
 - All ports on slots 1 through 4 have been assigned.

This example does use protocol-sensitive VLANs that admit only IP packets. This is not a common requirement for most networks. In most cases, VLANs will admit different types of packets to be forwarded to the hosts and servers on the network.

Figure 202: RIP Configuration Example



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The stations connected to the system generate a combination of IP traffic and NetBIOS traffic. The IP traffic is filtered by the protocol-sensitive VLANs. All other traffic is directed to the VLAN *MyCompany*.

In this configuration, all IP traffic from stations connected to slots 1 and 3 have access to the router by way of the VLAN *Finance*. Ports on slots 2 and 4 reach the router by way of the VLAN *Personnel*. All other traffic (NetBIOS) is part of the VLAN *MyCompany*.

The example in [Figure 202](#) is configured as follows:

```
create vlan Finance
create vlan Personnel
create vlan MyCompany

configure Finance protocol ip
configure Personnel protocol ip

configure Finance add port 1:*,3:*
configure Personnel add port 2:*,4:*
configure MyCompany add port all

configure Finance ipaddress 192.207.35.1
configure Personnel ipaddress 192.207.36.1

enable ipforwarding
configure rip add vlan all
enable rip
```

More commonly, NetBIOS traffic would be allowed on the *Finance* and *Personnel* VLANs, but this example shows how to exclude that traffic. To allow the NetBIOS traffic (or other type of traffic) along with the IP traffic, remove the `configure finance protocol ip` and `configure Personnel protocol ip` commands from the example.

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CHAPTER

RIPng

This chapter includes the following sections:

- [Overview on page 1283](#)
- [Overview of RIPng on page 1284](#)
- [Route Redistribution on page 1285](#)
- [RIPng Configuration Example on page 1286](#)

This chapter assumes that you are already familiar with IP unicast routing. If not, refer to the following publication for additional information:

- RFC 2080—*RIPng for IPv6*



NOTE

RIPng is available on platforms with an Edge, Advanced Edge or Core license. See [Appendix A, “Feature License Requirements”](#) for specific information regarding RIPng licensing

Overview

Routing Information Protocol Next Generation (RIPng) is an interior gateway protocol (IGP) developed for IPv6 networks. The analogous protocol used in IPv4 networks is called Routing Information Protocol (RIP). Like RIP, RIPng is a relatively simple protocol for the communication of routing information among routers. Many concepts and features of RIPng are directly parallel to those same features in RIP.

RIPng is a distance-vector protocol, based on the Bellman-Ford (or distance-vector) algorithm. The distance-vector algorithm has been in use for many years and is widely deployed and understood. The other common IGPs for IPv6 are Open Shortest Path First Version 3 (OSPFv3) and Intermediate System-Intermediate System (IS-IS), which are link-state protocols.



NOTE

RIPng can be enabled on a VLAN with either OSPFv3 or ISIS. OSPFv3 and ISIS cannot be enabled on the same VLAN.

RIPng is described in this chapter, OSPFv3 is described in [Chapter 36, “OSPFv3,”](#) and IS-IS is described in [Chapter 37, “IS-IS.”](#)

RIPng Versus OSPFv3 and IS-IS

The distinction between RIPng and the link-state protocols, OSPFv3 and IS-IS, lies in the fundamental differences between distance-vector protocols (RIPng) and link-state protocols. Using a distance-vector protocol, each router creates a unique routing table from summarized information obtained from neighboring routers. Using a link-state protocol, every router maintains an identical routing table created from information obtained from all routers in the autonomous system (AS). Each router builds a shortest path tree, using itself as the root. The link-state protocol ensures that updates sent to neighboring routers are acknowledged by the neighbors, verifying that all routers have a consistent network map.

Advantages of RIPng, OSPFv3, and IS-IS

The biggest advantage of using RIPng is that it is relatively simple to understand and to implement, and it has been the *de facto* routing standard for many years.

RIPng has a number of limitations that can cause problems in large networks, including the following:

- A limit of 15 hops between the source and destination networks
- A large amount of bandwidth taken up by periodic broadcasts of the entire routing table
- Slow convergence
- Routing decisions based on hop count; no concept of link costs or delay
- Flat networks; no concept of areas or boundaries

OSPFv3 and IS-IS offer many advantages over RIPng, including the following:

- No limitation on hop count
- Route updates multicast only when changes occur
- Faster convergence
- Support for load balancing to multiple routers based on the actual cost of the link
- Support for hierarchical topologies where the network is divided into areas

The details of RIPng are explained later in this chapter.

Overview of RIPng

RIPng is primarily intended for use in homogeneous networks of moderate size.

To determine the best path to a distant network, a router using RIPng always selects the path that has the least number of hops. Each router that data must traverse is considered to be one hop.

Routing Table

The routing table in a router using RIPng contains an entry for every known destination network. Each routing table entry contains the following information:

- IP address and prefix length of the destination network
- Metric (hop count) to the destination network
- IP address of the next hop router, if the destination is not directly connected
- Interface for the next hop
- Timer that tracks the amount of time since the entry was last updated
- A flag that indicates if the entry is a new one since the last update
- The source of the route, for example, static, RIPng, OSPFv3, etc.

The router exchanges an update message with each neighbor every 30 seconds (default value), or when there is a change to the overall routed topology (also called *triggered updates*). If a router does not receive an update message from its neighbor within the route timeout period (180 seconds by default), the router assumes the connection between it and its neighbor is no longer available.

Split Horizon

Split horizon is a scheme for avoiding problems caused by including routes in updates sent to the router from which the route was learned. Split horizon omits routes learned from a neighbor in updates sent to that neighbor.

Poison Reverse

Like split horizon, poison reverse is a scheme for eliminating the possibility of loops in the routed topology. In this case, a router advertises a route over the same interface that supplied the route, but the route uses a hop count of 16, which defines that router as unreachable.

Triggered Updates

Triggered updates occur whenever a router changes the metric for a route. The router is required to send an update message immediately, even if it is not yet time for a regular update message to be sent. This generally results in faster convergence, but may also result in more RIPng-related traffic.

Route Advertisement of VLANs

Virtual LANs (VLANs) that are configured with an IP address but are configured to not route IP or are not configured to run RIP, do not have their subnets advertised by RIP. RIP advertises *only* those VLANs that are configured with an IP address, are configured to route IP, and run RIP.

Route Redistribution

More than one routing protocol can be enabled simultaneously on the switch. Route redistribution allows the switch to exchange routes, including static routes, between the routing protocols. Route redistribution is also called route export.

Configuring Route Redistribution

Exporting routes from one protocol to another and from that protocol to the first one are discrete configuration functions. For example, to run OSPFv3 and RIPng simultaneously, you must first configure both protocols and then verify the independent operation of each. Then you can configure the routes to export from OSPFv3 to RIPng and the routes to export from RIPng to OSPFv3. Likewise, for any other combinations of protocols, you must separately configure each to export routes to the other.

Redistributing Routes into RIPng

Enable or disable the exporting of static, direct, or other protocol-learned routes into the RIPng domain using the following commands:

```
enable ripng export [direct | ospfv3 | ospfv3-extern1 | ospfv3-extern2 | ospfv3-inter
| ospfv3-intra | static | isis | isis-level-1| isis-level-1-external | isis-level-2|
isis-level-2-external | bgp] [cost <number> {tag <number>} | policy <policy-name>]
```

```
disable ripng export [direct | ospfv3 | ospfv3-extern1 | ospfv3-extern2 | ospfv3-inter
| ospfv3-intra | static | isis | isis-level-1| isis-level-1-external | isis-level-2|
isis-level-2-external | bgp]
```

These commands enable or disable the exporting of static, direct, and OSPF-learned routes into the RIPng domain. You can choose which types of OSPF routes are injected, or you can simply choose `ospf`, which will inject all learned OSPF routes regardless of type. The default setting is disabled.

RIPng Configuration Example

The following configuration is similar to the example in the RIP chapter, but uses IPv6 addresses. It illustrates a BlackDiamond switch that has three VLANs defined as follows:

- *Finance*
 - All ports on slots 1 and 3 have been assigned.
 - IP address 2001:db8:35::1/48.
- *Personnel*
 - All ports on slots 2 and 4 have been assigned.
 - IP address 2001:db8:36::1/48.
- *MyCompany*
 - Port-based VLAN.
 - All ports on slots 1 through 4 have been assigned.

The stations connected to the system generate a combination of IPv6 traffic and NetBIOS traffic.

In this configuration, all traffic from stations connected to slots 1 and 3 have access to the router by way of the VLAN *Finance*. Ports on slots 2 and 4 reach the router by way of the VLAN *Personnel*. All traffic (NetBIOS and IPv6) is part of the VLAN *MyCompany*.

The example is configured as follows:

```
create vlan Finance
create vlan Personnel
create vlan MyCompany
```

```
configure Finance add port 1:*,3:*
configure Personnel add port 2:*,4:*
configure MyCompany add port all

configure Finance ipaddress 2001:db8:35::1/48
configure Personnel ipaddress 2001:db8:36::1/48

enable ipforwarding ipv6
configure ripng add vlan Finance
configure ripng add vlan Personnel
enable ripng
```


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CHAPTER

OSPF

This chapter includes the following sections:

- [Overview on page 1289](#)
- [Route Redistribution on page 1296](#)
- [Configuring OSPF on page 1298](#)
- [OSPF Configuration Example on page 1299](#)
- [Displaying OSPF Settings on page 1301](#)

This chapter assumes that you are already familiar with IP unicast routing. If not, refer to the following publications for additional information:

- RFC 2328—*OSPF Version 2*
- RFC 1765—*OSPF Database Overflow*
- RFC 2370—*The OSPF Opaque LSA Option*
- RFC 3101—*The OSPF Not-So-Stubby Area (NSSA) Option*
- RFC 3623—*Graceful OSPF Restart*
- *Interconnections: Bridges and Routers*
by Radia Perlman
ISBN 0-201-56332-0
Published by Addison-Wesley Publishing Company



NOTE

OSPF is available on platforms with an Advanced Edge or Core license. See [Appendix A, “Feature License Requirements”](#) for specific information regarding OSPF licensing.

Overview

Open Shortest Path First (OSPF) is a link state protocol that distributes routing information between routers belonging to a single IP domain; the IP domain is also known as an *autonomous system* (AS). In a link-state routing protocol, each router maintains a database describing the topology of the AS. Each participating router has an identical database maintained from the perspective of that router.

From the link state database (LSDB), each router constructs a tree of shortest paths, using itself as the root. The shortest path tree provides the route to each destination in the AS. When several equal-cost routes to a destination exist, traffic can be distributed among them. The cost of a route is described by a single metric.

OSPF is an interior gateway protocol (IGP), as is the other common IGP—RIP. OSPF and RIP are compared in [Chapter 33, “RIP.”](#)

**NOTE**

Two types of OSPF functionality are available and each has a different licensing requirement. One is the complete OSPF functionality and the other is OSPF Edge Mode, a subset of OSPF that is described below. See [Appendix A, “Feature License Requirements”](#) for specific information regarding OSPF licensing.

OSPF Edge Mode

OSPF Edge Mode is a subset of OSPF available on platforms with an Advanced Edge license. There are two restrictions on OSPF Edge Mode:

- At most, four Active OSPF VLAN interfaces are permitted. There is no restriction on the number of Passive interfaces.
- The OSPF Priority on VLANs is 0, and is not configurable. This prevents the system from acting as a DR or BDR

Link State Database

Upon initialization, each router transmits a link state advertisement (LSA) on each of its interfaces. LSAs are collected by each router and entered into the LSDB of each router. After all LSAs are received, the router uses the LSDB to calculate the best routes for use in the IP routing table. OSPF uses flooding to distribute LSAs between routers. Any change in routing information is sent to all of the routers in the network. All routers within an area have the exact same LSDB. [Table 129](#) describes LSA type numbers.

Table 129: LSA Type Numbers

Type Number	Description
1	Router LSA
2	Network LSA
3	Summary LSA
4	AS summary LSA
5	AS external LSA
7	NSSA external LSA
9	Link local—Opaque
10	Area scoping—Opaque
11	AS scoping—Opaque

Database Overflow

The OSPF database overflow feature allows you to limit the size of the LSDB and to maintain a consistent LSDB across all the routers in the domain, which ensures that all routers have a consistent view of the network.

Consistency is achieved by:

- Limiting the number of external LSAs in the database of each router
- Ensuring that all routers have identical LSAs

To configure OSPF database overflow, use the following command:

```
configure ospf ase-limit <number> {timeout <seconds>}
```

Where:

- `<number>`—Specifies the number of external LSAs that the system supports before it goes into overflow state. A limit value of 0 disables the functionality.

When the LSDB size limit is reached, OSPF database overflow flushes LSAs from the LSDB. OSPF database overflow flushes the same LSAs from all the routers, which maintains consistency.

- `timeout`—Specifies the timeout, in seconds, after which the system ceases to be in overflow state. A timeout value of 0 leaves the system in overflow state until OSPF is disabled and re-enabled.

Opaque LSAs

Opaque LSAs are a generic OSPF mechanism used to carry auxiliary information in the OSPF database. Opaque LSAs are most commonly used to support OSPF traffic engineering.

Normally, support for opaque LSAs is autonegotiated between OSPF neighbors. In the event that you experience interoperability problems, you can disable opaque LSAs across the entire system using the following command:

```
disable ospf capability opaque-lsa
```

To re-enable opaque LSAs across the entire system, use the following command:

```
enable ospf capability opaque-lsa
```

If your network uses opaque LSAs, Extreme Networks recommends that all routers on your OSPF network support opaque LSAs. Routers that do not support opaque LSAs do not store or flood them. At minimum a well interconnected subsection of your OSPF network must support opaque LSAs to maintain reliability of their transmission.

Graceful OSPF Restart

RFC 3623 describes a way for OSPF control functions to restart without disrupting traffic forwarding. Without graceful restart, adjacent routers will assume that information previously received from the restarting router is stale and will not be used to forward traffic to that router. However, in many cases, two conditions exist that allow the router restarting OSPF to continue to forward traffic correctly. The first condition is that forwarding can continue while the control function is restarted. Most modern router system designs separate the forwarding function from the control function so that traffic can still be forwarded independent of the state of the OSPF function. Routes learned through OSPF remain in the routing table and packets continue to be forwarded. The second condition required for graceful restart is that the network remain stable during the restart period. If the network topology is not

changing, the current routing table remains correct. Often, networks can remain stable during the time for restarting OSPF.

Restarting and Helper Mode

Routers involved with graceful restart fill one of two roles: the restarting router or the helper router. With graceful restart, the router that is restarting sends out Grace-LSAs informing its neighbors that it is in graceful restart mode, how long the helper router should assist with the restart (the grace period), and why the restart occurred. If the neighboring routers are configured to help with the graceful restart (helper-mode), they will continue to advertise the restarting router as if it was fully adjacent. Traffic continues to be routed as though the restarting router is fully functional. If the network topology changes, the helper routers will stop advertising the restarting router. The helper router will continue in helper mode until the restarting router indicates successful termination of graceful restart, the Grace-LSAs expire, or the network topology changes. A router can be configured for graceful restart, and for helper-mode separately. A router can be a helper when its neighbor restarts, and can in turn be helped by a neighbor if it restarts.

Planned and Unplanned Restarts

Two types of graceful restarts are defined: planned and unplanned. A planned restart would occur if the software module for OSPF was upgraded, or if the router operator decided to restart the OSPF control function for some reason. The router has advance warning, and is able to inform its neighbors in advance that OSPF is restarting. An unplanned restart would occur if there was some kind of system failure that caused a remote reboot or a crash of OSPF, or an MSM/MM failover occurs. As OSPF restarts, it informs its neighbors that it is in the midst of an unplanned restart. You can decide to configure a router to enter graceful restart for only planned restarts, for only unplanned restarts, or for both. Also, you can separately decide to configure a router to be a helper for only planned, only unplanned, or for both kinds of restarts.

Configuring Graceful OSPF Restart

To configure a router to perform graceful OSPF restart, use the following command:

```
configure ospf restart [none | planned | unplanned | both]
```

Since a router can act as a restart helper router to multiple neighbors, you will specify which neighbors to help. To configure a router to act as a graceful OSPF restart helper, use the following command:

```
configure ospf [vlan [all | <vlan-name>] | area <area-identifier> | virtual-link
<router-identifier> <area-identifier>] restart-helper [none | planned | unplanned |
both]
```

The graceful restart period sent out to helper routers can be configured with the following command:

```
configure ospf restart grace-period <seconds>
```

By default, a helper router will terminate graceful restart if received LSAs would affect the restarting router. This will occur when the restart-helper receives an LSA that will be flooded to the restarting router or when there is a changed LSA on the restarting router's retransmission list when graceful restart is initiated. To disable this behavior, use the following command:

```
disable ospf [vlan [all | <vlan-name>] | area <area-identifier> | virtual-link
<router-identifier> <area-identifier>] restart-helper-lsa-check
```

Areas

OSPF allows parts of a network to be grouped together into *areas*. The topology within an area is hidden from the rest of the AS. Hiding this information enables a significant reduction in LSA traffic and reduces the computations needed to maintain the LSDB. Routing within the area is determined only by the topology of the area.

The three types of routers defined by OSPF are as follows:

- Internal router (IR)—An internal router has all of its interfaces within the same area.
- Area border router (ABR)—An ABR has interfaces in multiple areas. It is responsible for exchanging summary advertisements with other ABRs.
- Autonomous system border router (ASBR)—An ASBR acts as a gateway between OSPF and other routing protocols, or other autonomous systems.

Backbone Area (Area 0.0.0.0)

Any OSPF network that contains more than one area is required to have an area configured as area 0.0.0.0, also called the *backbone*. All areas in an AS must be connected to the backbone. When designing networks, you should start with area 0.0.0.0 and then expand into other areas.



NOTE

Area 0.0.0.0 exists by default and cannot be deleted or changed.

The backbone allows summary information to be exchanged between ABRs. Every ABR hears the area summaries from all other ABRs. The ABR then forms a picture of the distance to all networks outside of its area by examining the collected advertisements and adding in the backbone distance to each advertising router.

When a VLAN is configured to run OSPF, you must configure the area for the VLAN. If you want to configure the VLAN to be part of a different OSPF area, use the following command:

```
configure ospf vlan <vlan-name> area <area-identifier>
```

If this is the first instance of the OSPF area being used, you must create the area first using the following command:

```
create ospf area <area-identifier>
```

Stub Areas

OSPF allows certain areas to be configured as *stub areas*. A stub area is connected to only one other area. The area that connects to a stub area can be the backbone area. External route information is not distributed into stub areas. Stub areas are used to reduce memory consumption and computational requirements on OSPF routers. Use the following command to configure an OSPF area as a stub area:

```
configure ospf area <area-identifier> stub [summary | nosummary] stub-default-cost <cost>
```

Not-So-Stubby-Areas

Not-so-stubby-areas (NSSAs) are similar to the existing OSPF stub area configuration option but have the following two additional capabilities:

- External routes originating from an ASBR connected to the NSSA can be advertised within the NSSA.
- External routes originating from the NSSA can be propagated to other areas, including the backbone area.

The command line interface (CLI) command to control the NSSA function is similar to the command used for configuring a stub area, as follows:

```
configure ospf area <area-identifier> nssa [summary | nosummary] stub-default-cost <cost> {translate}
```

The `translate` option determines whether type 7 LSAs are translated into type 5 LSAs. When configuring an OSPF area as an NSSA, `translate` should only be used on NSSA border routers, where translation is to be enforced. If `translate` is not used on any NSSA border router in a NSSA, one of the ABRs for that NSSA is elected to perform translation (as indicated in the NSSA specification). The option should not be used on NSSA internal routers. Doing so inhibits correct operation of the election algorithm.

Normal Area

A normal area is an area that is not:

- Area 0
- Stub area
- NSSA

Virtual links can be configured through normal areas. External routes can be distributed into normal areas.

Virtual Links

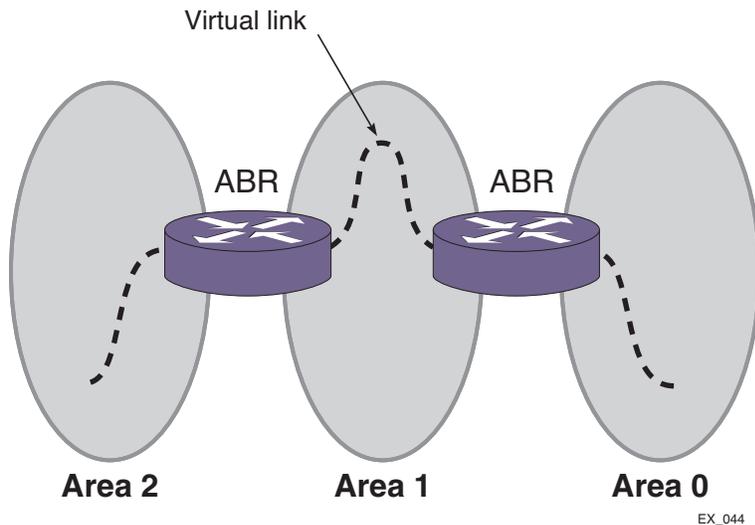
In the situation when a new area is introduced that does not have a direct physical attachment to the backbone, a *virtual link* is used. A virtual link provides a logical path between the ABR of the disconnected area and the ABR of the normal area that connects to the backbone. A virtual link must be established between two ABRs that have a common area, with one ABR connected to the backbone. [Figure 203](#) illustrates a virtual link.



NOTE

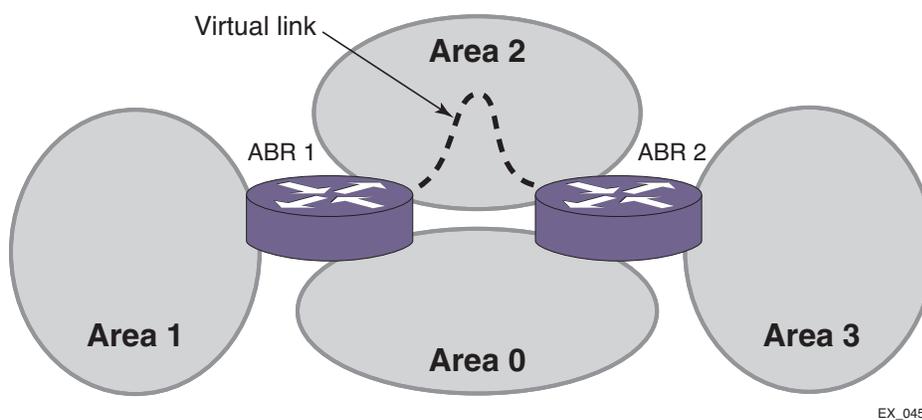
Virtual links cannot be configured through a stub or NSSA area.

Figure 203: Virtual Link Using Area1 as a Transit Area



Virtual links are also used to repair a discontinuous backbone area. For example, in [Figure 204](#), if the connection between ABR1 and the backbone fails, the connection using ABR2 provides redundancy so that the discontinuous area can continue to communicate with the backbone using the virtual link.

Figure 204: Virtual Link Providing Redundancy



Point-to-Point Support

You can manually configure the OSPF link type for a VLAN. [Table 130](#) describes the link types.

Table 130: OSPF Link Types

Link Type	Number of Routers	Description
Auto	Varies	ExtremeXOS automatically determines the OSPF link type based on the interface type. This is the default setting.
Broadcast	Any	Routers must elect a designated router (DR) and a backup designated router (BDR) during synchronization. Ethernet is an example of a broadcast link.

Table 130: OSPF Link Types (Continued)

Link Type	Number of Routers	Description
Point-to-point	Up to 2	This type synchronizes faster than a broadcast link because routers do not elect a DR or BDR. It does not operate with more than two routers on the same VLAN. The Point-to-Point Protocol (PPP) is an example of a point-to-point link. An OSPF point-to-point link supports only zero to two OSPF routers and does not elect a designated router (DR) or backup designated router (BDR). If you have three or more routers on the VLAN, OSPF fails to synchronize if the neighbor is not configured.
Passive		A passive link does not send or receive OSPF packets.

**NOTE**

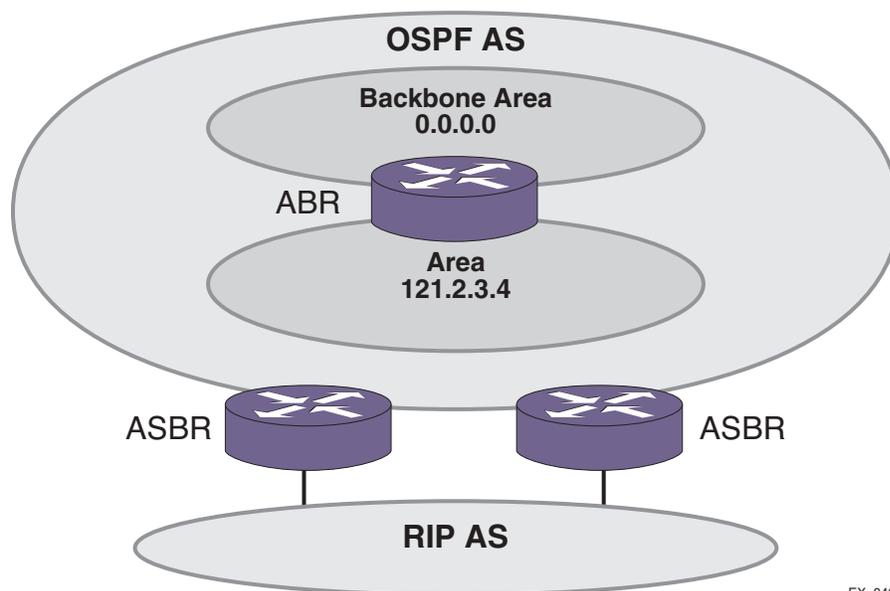
The number of routers in an OSPF point-to-point link is determined per VLAN, not per link.

**NOTE**

All routers in the VLAN must have the same OSPF link type. If there is a mismatch, OSPF attempts to operate, but it may not be reliable.

Route Redistribution

More than one routing protocol can be enabled simultaneously on the switch. Route redistribution allows the switch to exchange routes, including static routes, between the routing protocols. [Figure 205](#) is an example of route redistribution between an OSPF AS and a RIP AS.

Figure 205: Route Redistribution

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Configuring Route Redistribution

Exporting routes from one protocol to another and from that protocol to the first one are discrete configuration functions. For example, to run OSPF and RIP simultaneously, you must first configure both protocols and then verify the independent operation of each. Then you can configure the routes to export from OSPF to RIP and the routes to export from RIP to OSPF. Likewise, for any other combinations of protocols, you must separately configure each to export routes to the other.

Redistributing Routes into OSPF

To enable or disable the exporting of BGP, RIP, static, and direct (interface) routes to OSPF, use the following commands:

```
enable ospf export [bgp | direct | e-bgp | i-bgp | rip | static | isis | isis-level-1
| isis-level-1-external | isis-level-2 | isis-level-2-external] [cost <cost> type
[ase-type-1 | ase-type-2] {tag <number>} | <policy-map>]
```

```
disable ospf export [bgp | direct | e-bgp | i-bgp | rip | static | isis | isis-level-1
| isis-level-1-external | isis-level-2 | isis-level-2-external]
```

These commands enable or disable the exporting of RIP, static, and direct routes by way of LSA to other OSPF routers as AS-external type 1 or type 2 routes. The default setting is disabled.

The cost metric is inserted for all Border Gateway Protocol (BGP), RIP, static, and direct routes injected into OSPF. If the cost metric is set to 0, the cost is inserted from the route. For example, in the case of BGP export, the cost equals the multiple exit discriminator (MED) or the path length. The tag value is used only by special routing applications. Use 0 if you do not have specific requirements for using a tag. (The tag value in this instance has no relationship with IEEE 802.1Q VLAN tagging.)

The same cost, type, and tag values can be inserted for all the export routes, or policies can be used for selective insertion. When a policy is associated with the export command, the policy is applied on every exported route. The exported routes can also be filtered using policies.



NOTE

For routes exported to OSPF via a policy file, any refresh applied on that policy may result in temporary withdrawal and then immediate readvertising of those routes.

Verify the configuration using the command:

```
show ospf
```

OSPF Timers and Authentication

Configuring OSPF timers and authentication on a per area basis is a shortcut to applying the timers and authentication to each VLAN in the area at the time of configuration. If you add more VLANs to the area, you must configure the timers and authentication for the new VLANs explicitly. Use the command:

```
configure ospf vlan [<vlan-name> | all] timer <retransmit-interval> <transit-delay>
<hello-interval> <dead-interval> {<wait-timer-interval>}
```

Configuring OSPF

Each switch that is configured to run OSPF must have a unique router ID. Extreme Networks recommends that you manually set the router ID of the switches participating in OSPF, instead of having the switch automatically choose its router ID based on the highest interface IP address. Not performing this configuration in larger, dynamic environments could result in an older LSDB remaining in use.

Configuring OSPF Wait Interval

ExtremeXOS allows you to configure the OSPF wait interval, rather than using the router dead interval.



CAUTION

Do not configure OSPF timers unless you are comfortable exceeding OSPF specifications. Non-standard settings may not be reliable under all circumstances.

To specify the timer intervals, use the following commands:

```
configure ospf area <area-identifier> timer <retransmit-interval> <transit-delay>
<hello-interval> <dead-interval> {<wait-timer-interval>}
```

```
configure ospf virtual-link <router-identifier> <area-identifier> timer <retransmit-
interval> <transit-delay> <hello-interval> <dead-interval>
```

```
configure ospf vlan [<vlan-name> | all] timer <retransmit-interval> <transit-delay>
<hello-interval> <dead-interval> {<wait-timer-interval>}
```

OSPF Wait Interval Parameters

You can configure the following parameters:

- Retransmit interval—The length of time that the router waits before retransmitting an LSA that is not acknowledged. If you set an interval that is too short, unnecessary retransmissions result. The default value is 5 seconds.
- Transit delay—The length of time it takes to transmit an LSA packet over the interface. The transit delay must be greater than 0.
- Hello interval—The interval at which routers send hello packets. Shorter times allow routers to discover each other more quickly but also increase network traffic. The default value is 10 seconds.
- Dead router wait interval (Dead Interval)—The interval after which a neighboring router is declared down because hello packets are no longer received from the neighbor. This interval should be a multiple of the hello interval. The default value is 40 seconds.
- Router wait interval (Wait Timer Interval)—The interval between the interface coming up and the election of the DR and BDR. This interval should be greater than the hello interval. If this time is close to the hello interval, the network synchronizes very quickly but might not elect the correct DR or BDR. The default value is equal to the dead router wait interval.



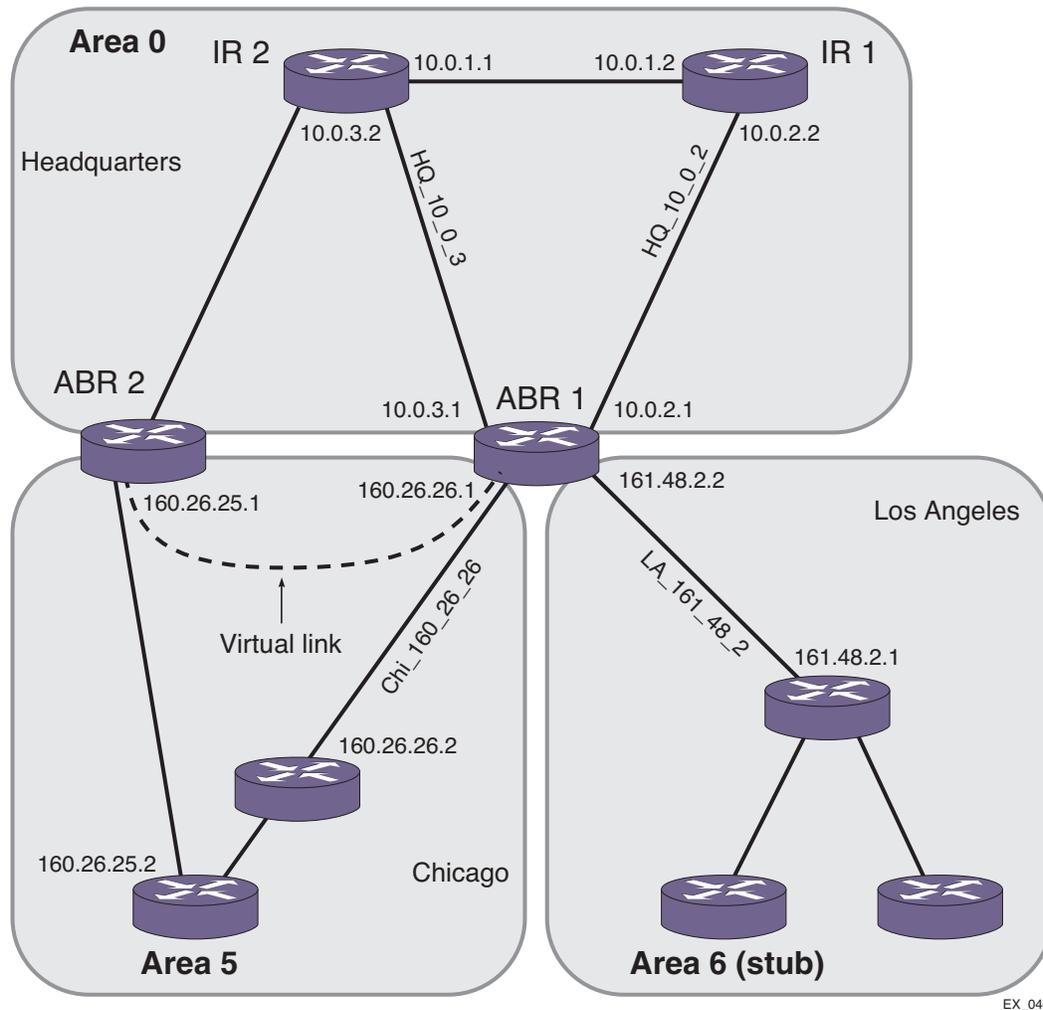
NOTE

The OSPF standard specifies that wait times are equal to the dead router wait interval.

OSPF Configuration Example

Figure 206 is an example of an autonomous system using OSPF routers. The details of this network follow.

Figure 206: OSPF Configuration Example



Area 0 is the backbone area. It is located at the headquarters and has the following characteristics:

- Two internal routers (IR1 and IR2)
- Two area border routers (ABR1 and ABR2)
- Network number 10.0.x.x
- Two identified VLANs (HQ_10_0_2 and HQ_10_0_3)

Area 5 is connected to the backbone area by way of ABR1 and ABR2. It is located in Chicago and has the following characteristics:

- Network number 160.26.x.x
- One identified VLAN (Chi_160_26_26)
- Two internal routers

Area 6 is a stub area connected to the backbone by way of ABR1. It is located in Los Angeles and has the following characteristics:

- Network number 161.48.x.x
- One identified VLAN (LA_161_48_2)
- Three internal routers
- Uses default routes for inter-area routing

Two router configurations for the example in [Figure 206](#) are provided in the following section.

Configuration for ABR1

The router labeled ABR1 has the following configuration:

```
create vlan HQ_10_0_2
create vlan HQ_10_0_3
create vlan LA_161_48_2
create vlan Chi_160_26_26

configure vlan HQ_10_0_2 ipaddress 10.0.2.1 255.255.255.0
configure vlan HQ_10_0_3 ipaddress 10.0.3.1 255.255.255.0
configure vlan LA_161_48_2 ipaddress 161.48.2.2 255.255.255.0
configure vlan Chi_160_26_26 ipaddress 160.26.26.1 255.255.255.0

create ospf area 0.0.0.5
create ospf area 0.0.0.6

enable ipforwarding

configure ospf area 0.0.0.6 stub nosummary stub-default-cost 10
configure ospf add vlan LA_161_48_2 area 0.0.0.6
configure ospf add vlan Chi_160_26_26 area 0.0.0.5
configure ospf add vlan HQ_10_0_2 area 0.0.0.0
configure ospf add vlan HQ_10_0_3 area 0.0.0.0
configure ospf vlan LA_161_48_2 priority 10
configure ospf vlan Chi_160_26_26 priority 10
configure ospf vlan HQ_10_0_2 priority 5
configure ospf vlan HQ_10_0_3 priority 5

enable ospf
```

Configuration for IR1

The router labeled IR1 has the following configuration:

```
configure vlan HQ_10_0_1 ipaddress 10.0.1.2 255.255.255.0
configure vlan HQ_10_0_2 ipaddress 10.0.2.2 255.255.255.0
enable ipforwarding
configure ospf add vlan all area 0.0.0.0
configure ospf area 0.0.0.0 priority 10
enable ospf
```

**NOTE**

In OSPF edge mode, the VLAN priority is “0” and cannot be set. (Refer to “[OSPF Edge Mode](#)” on [page 1290](#).) When the license is upgraded to a Core license, the VLAN priority of “0” needs to be reset in order to participate in DR/BDR election.

Displaying OSPF Settings

You can use a number of commands to display settings for OSPF. To show global OSPF information, use the `show ospf` command with no options.

To display information about one or all OSPF areas, use the following command:

```
show ospf area {detail | <area-identifier>}
```

The `detail` option displays information about all OSPF areas in a detail format.

To display information about OSPF interfaces for an area, a VLAN, or for all interfaces, use the following command:

```
show ospf interfaces {vlan <vlan-name> | area <area-identifier> | enabled}
```

The `detail` option displays information about all OSPF interfaces in a detail format.

ExtremeXOS provides several filtering criteria for the `show ospf lsdb` command. You can specify multiple search criteria, and only those results matching all of the criteria are displayed. This allows you to control the displayed entries in large routing tables.

To display the current link-state database, use the following command:

```
show ospf lsdb {detail | stats} {area [<area-identifier> | all]} {{lstype} [<lstype> | all]} {lsid <lsid-address>{<lsid-mask>}} {routerid <routerid-address> {<routerid-mask>}} {interface[ [<ip-address>{<ip-mask>} | <ipNetmask>] | vlan <vlan-name>]}
```

The `detail` option displays all fields of matching LSAs in a multiline format. The `summary` option displays several important fields of matching LSAs, one line per LSA. The `stats` option displays the number of matching LSAs but not any of their contents. If not specified, the default is to display in the summary format.

A common use of this command is to omit all optional parameters, resulting in the following shortened form:

```
show ospf lsdb
```

The shortened form displays LSAs from all areas and all types in a summary format.

36

CHAPTER

OSPFv3

This chapter includes the following sections:

- [Overview on page 1303](#)
- [Route Redistribution on page 1307](#)



NOTE

OSPFv3 is available on platforms with an Advanced Edge or Core license. See [Appendix A, “Feature License Requirements”](#) for information about OSPFv3 licensing.

Overview

Open Shortest Path First (OSPF) is a link state protocol that distributes routing information between routers belonging to a single IP domain; the IP domain is also known as an *autonomous system* (AS). In a link-state routing protocol, each router maintains a database describing the topology of the AS. Each participating router has an identical database for an area maintained from the perspective of that router.

From the link state database (LSDB), each router constructs a tree of shortest paths, using itself as the root. The shortest path tree provides the route to each destination in the AS. When several equal-cost routes to a destination exist, traffic can be distributed among them. The cost of a route is described by a single metric.

OSPFv3 supports IPv6, and uses commands only slightly modified from that used to support IPv4. OSPFv3 has retained the use of the 4-byte, dotted decimal numbers for router IDs, LSA IDs, and area IDs.

OSPFv3 is an interior gateway protocol (IGP), as is the other common IGP for IPv6, RIPng. OSPFv3 and RIPng are compared in [Chapter 34, “RIPng.”](#)



NOTE

Two types of OSPFv3 functionality are available and each has a different licensing requirement. One is the complete OSPFv3 functionality and the other is OSPFv3 Edge Mode, a subset of OSPFv3 that is described below. See [Appendix A, “Feature License Requirements”](#) for specific information regarding OSPFv3 licensing.

OSPFv3 Edge Mode

OSPFv3 Edge Mode is a subset of OSPFv3 available on platforms with an Advanced Edge license. There are two restrictions on OSPFv3 Edge Mode:

- At most, four Active OSPFv3 VLAN interfaces are permitted. There is no restriction on the number of Passive interfaces.
- The OSPFv3 Priority on VLANs is 0, and is not configurable. This prevents the system from acting as a DR or BDR

Link State Database

Upon initialization, each router transmits a link state advertisement (LSA) on each of its interfaces. LSAs are collected by each router and stored into the LSDB of each router. After all LSAs are received, the router uses the LSDB to calculate the best routes for use in the IP routing table. OSPFv3 uses flooding to distribute LSAs between routers. Any change in routing information is sent to all of the routers in the network. All routers within an area have the exact same LSDB.

Table 131 describes LSA type numbers.

Table 131: Selected OSPFv3 LSA Types

Type Number	Description
0x0008	Link LSA
0x2001	Router LSA
0x2002	Network LSA
0x2003	Inter-Area-Prefix LSA
0x2004	Inter-Area-Router LSA
0x2009	Intra-Area-Prefix LSA
0x4005	AS external LSA

Areas

OSPFv3 allows parts of a network to be grouped together into *areas*. The topology within an area is hidden from the rest of the AS. Hiding this information enables a significant reduction in LSA traffic and reduces the computations needed to maintain the LSDB. Routing within the area is determined only by the topology of the area.

The three types of routers defined by OSPFv3 are as follows:

- Internal router (IR)—An internal router has all of its interfaces within the same area.
- Area border router (ABR)—An ABR has interfaces in multiple areas. It is responsible for exchanging summary advertisements with other ABRs.
- Autonomous system border router (ASBR)—An ASBR acts as a gateway between OSPFv3 and other routing protocols, or other autonomous systems.

Backbone Area (Area 0.0.0.0)

Any OSPFv3 network that contains more than one area is required to have an area configured as area 0.0.0.0, also called the *backbone*. All areas in an AS must be connected to the backbone. When designing networks, you should start with area 0.0.0.0 and then expand into other areas.

**NOTE**

Area 0.0.0.0 exists by default and cannot be deleted or changed.

The backbone allows summary information to be exchanged between ABRs. Every ABR hears the area summaries from all other ABRs. The ABR then forms a picture of the distance to all networks outside of its area by examining the collected advertisements and adding in the backbone distance to each advertising router.

When a VLAN is configured to run OSPFv3, you must configure the area for the VLAN. If you want to configure the VLAN to be part of a different OSPFv3 area, use the following command:

```
configure ospfv3 {domain <domainName>} [vlan <vlan-name> | tunnel <tunnel-name>] area <area-identifier>
```

**NOTE**

The only domain name currently supported is `OSPF-Default`.

If this is the first instance of the OSPFv3 area being used, you must create the area first using the following command:

```
create ospfv3 {domain <domainName>} area <area-identifier>
```

Stub Areas

OSPFv3 allows certain areas to be configured as *stub areas*. A stub area is connected to only one other area. The area that connects to a stub area can be the backbone area. External route information is not distributed into stub areas. Stub areas are used to reduce memory consumption and computational requirements on OSPFv3 routers. To configure an OSPFv3 area as a stub area, use the following command:

```
configure ospfv3 {domain <domainName>} area <area-identifier> stub [summary | nosummary] stub-default-cost <cost>
```

Not-So-Stubby-Areas

Not-so-stubby-areas (NSSAs) are not supported currently in the ExtremeXOS implementation of OSPFv3.

Normal Area

A normal area is an area that is not:

- Area 0
- Stub area
- NSSA

Virtual links can be configured through normal areas. External routes can be distributed into normal areas.

Virtual Links

In the situation when a new area is introduced that does not have a direct physical attachment to the backbone, a *virtual link* is used. A virtual link provides a logical path between the ABR of the disconnected area and the ABR of the normal area that connects to the backbone. A virtual link must be established between two ABRs that have a common area, with one ABR connected to the backbone.

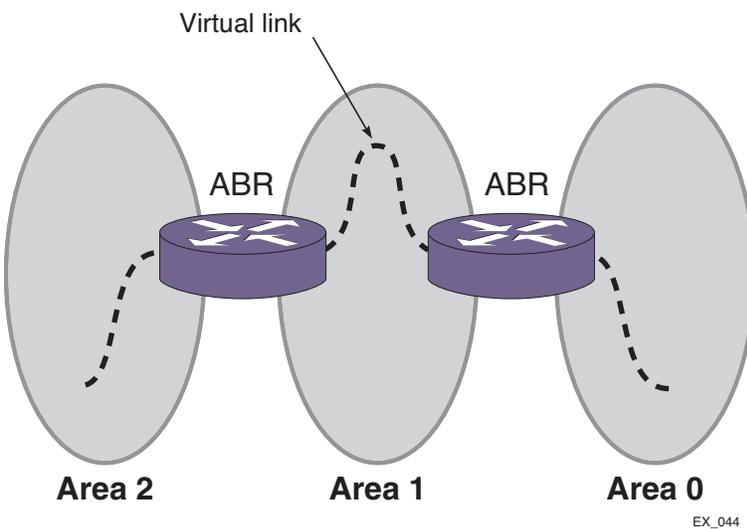
Figure 207 illustrates a virtual link.



NOTE

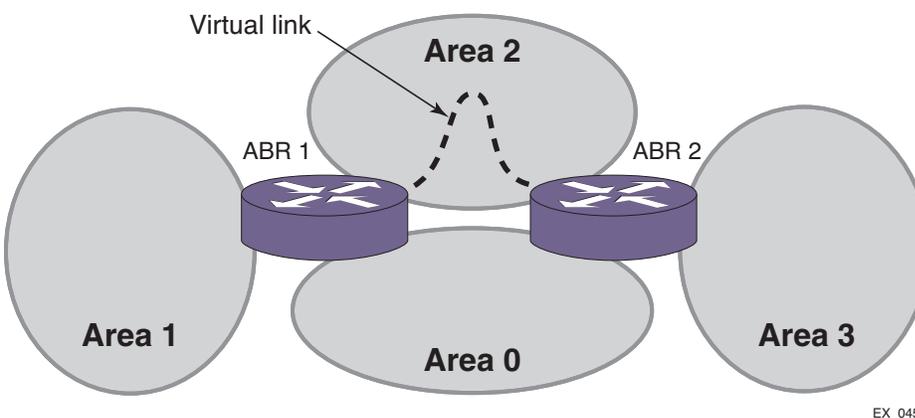
Virtual links cannot be configured through a stub or NSSA area.

Figure 207: Virtual Link Using Area 1 as a Transit Area



Virtual links are also used to repair a discontinuous backbone area. For example, in Figure 208, if the connection between ABR1 and the backbone fails, the connection using ABR2 provides redundancy so that the discontinuous area can continue to communicate with the backbone using the virtual link.

Figure 208: Virtual Link Providing Redundancy



Link-Type Support

You can manually configure the OSPFv3 link type for a VLAN. [Table 132](#) describes the link types.

Table 132: OSPFv3 Link Types

Link Type	Number of Routers	Description
Auto	Varies	ExtremeXOS automatically determines the OSPFv3 link type based on the interface type. This is the default setting.
Broadcast	Any	Routers must elect a designated router (DR) and a backup designated router (BDR) during synchronization. Ethernet is an example of a broadcast link.
Passive		A passive link does not send or receive OSPFv3 packets.



NOTE

The number of routers in an OSPFv3 point-to-point link is determined per VLAN, not per link.



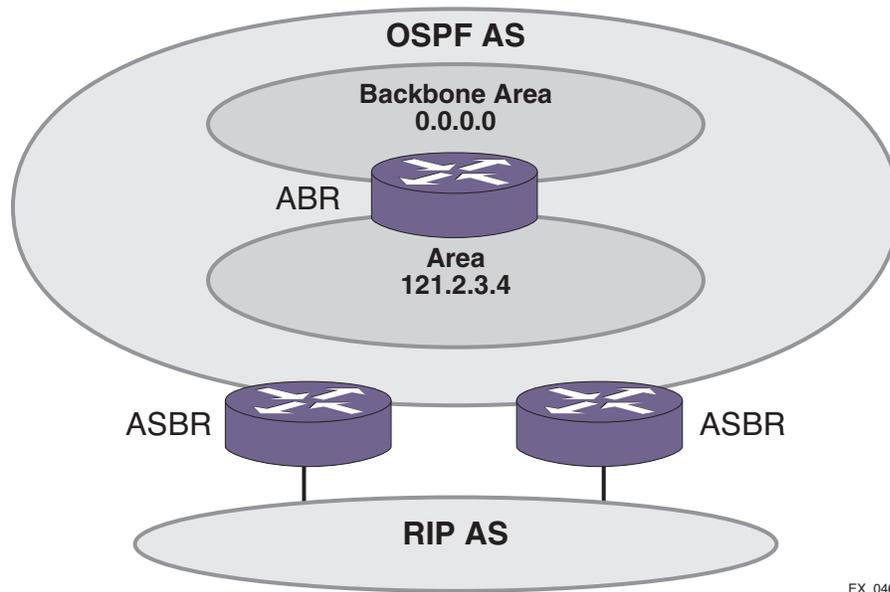
NOTE

All routers in the VLAN must have the same OSPFv3 link type. If there is a mismatch, OSPFv3 attempts to operate, but it may not be reliable.

Route Redistribution

More than one routing protocol can be enabled simultaneously on the switch. Route redistribution allows the switch to exchange routes, including static routes, between the routing protocols. [Figure 209](#) is an example of route redistribution between an OSPFv3 AS and a RIPng AS.

Figure 209: Route Redistribution



EX_046

Configuring Route Redistribution

Exporting routes from one protocol to another and from that protocol to the first one are discrete configuration functions. For example, to run OSPFv3 and RIPng simultaneously, you must first configure both protocols and then verify the independent operation of each. Then you can configure the routes to export from OSPFv3 to RIPng and the routes to export from RIPng to OSPFv3. Likewise, for any other combinations of protocols, you must separately configure each to export routes to the other.

Redistributing Routes into OSPFv3

To enable or disable the exporting of RIPng, static, and direct (interface) routes to OSPFv3, use the following commands:

```
enable ospfv3 {domain <domainName>} export [direct | ripng | static | isis | isis-
level-1 | isis-level-1-external | isis-level-2 | isis-level-2-external | bgp]
[cost <cost> type [ase-type-1 | ase-type-2] | <policy-map>]
```

```
disable ospfv3 {domain <domainName>} export [direct | ripng | static | isis | isis-
level-1 | isis-level-1-external | isis-level-2 | isis-level-2-external | bgp]
```

These commands enable or disable the exporting of RIPng, static, and direct routes by way of LSA to other OSPFv3 routers as AS-external type 1 or type 2 routes. The default setting is disabled.

The cost metric is inserted for all RIPng, static, and direct routes injected into OSPFv3. If the cost metric is set to 0, the cost is inserted from the route. The tag value is used only by special routing applications. Use 0 if you do not have specific requirements for using a tag. (The tag value in this instance has no relationship with IEEE 802.1Q VLAN tagging.)

The same cost, type, and tag values can be inserted for all the export routes, or policies can be used for selective insertion. When a policy is associated with the export command, the policy is applied on every exported route. The exported routes can also be filtered using policies.

**NOTE**

For routes exported to OSPF via a policy file, any refresh applied on that policy may result in temporary withdrawal and then immediate readvertising of those routes.

Verify the configuration using the command:

```
show ospfv3 {domain <domainName>}
```

OSPFv3 Timers

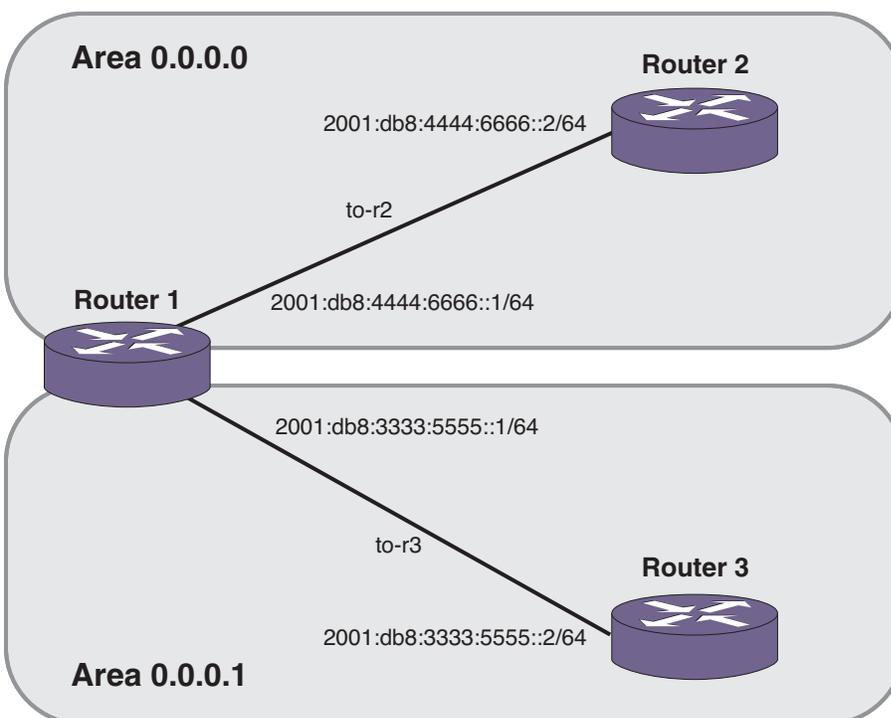
Configuring OSPFv3 timers on a per area basis is a shortcut to applying the timers to each VLAN in the area at the time of configuration. If you add more VLANs to the area, you must configure the timers for the new VLANs explicitly. Use the command:

```
configure ospfv3 {domain <domainName>} [vlan <vlan-name> | tunnel <tunnel-name> |
[vlan | tunnel] all] timer {retransmit-interval} <retransmit-interval> {transit-delay}
<transit-delay> {hello-interval} <hello-interval> {dead-interval} <dead-interval>
```

OSPFv3 Configuration Example

Figure 210 is an example of an autonomous system using OSPFv3 routers. The details of this network follow.

Figure 210: OSPFv3 Configuration Example



EX_107

In [Figure 210](#) there are three Extreme Networks switches running ExtremeXOS images that have support for OSPFv3. Router 1 is an area border router and is connected to two other switches Router 2 and Router 3. Router 1 runs OSPFv3 on both the links connecting it to Router 2 and Router 3.

The router configurations for the example in [Figure 210](#) are provided in the following section. After doing all the configurations, Router 1 will establish OSPFv3 adjacency with Router 2 and Router 3. They will also exchange the various link state databases.

Configuration for Router 1

The router labeled Router 1 has the following configuration:

```
create vlan to-r2
create vlan to-r3
configure vlan to-r2 ipaddress 2001:db8:4444:6666::1/64
configure vlan to-r3 ipaddress 2001:db8:3333:5555::1/64
configure vlan to-r2 add port 1:1
configure vlan to-r3 add port 1:2
enable ipforwarding ipv6

configure ospfv3 routerid 0.0.0.1
configure ospfv3 add vlan to-r2 area 0.0.0.0
create ospfv3 area 0.0.0.1
configure ospfv3 add vlan to-r3 area 0.0.0.1

enable ospfv3
```

Configuration for Router 2

The router labeled Router 2 has the following configuration:

```
create vlan to-r1
configure vlan to-r1 ipaddress 2001:db8:4444:6666::2/64
configure vlan to-r1 add port 1:1
enable ipforwarding ipv6

configure ospfv3 routerid 0.0.0.2
configure ospfv3 add vlan to-r1 area 0.0.0.0

enable ospfv3
```

Configuration for Router 3

The router labeled Router 3 has the following configuration:

```
create vlan to-r1
configure vlan to-r1 ipaddress 2001:db8:3333:5555::3/64
configure vlan to-r1 add port 1:1
enable ipforwarding ipv6

configure ospfv3 routerid 0.0.0.3
configure ospfv3 add vlan to-r1 area 0.0.0.1

enable ospfv3
```

37 IS-IS

CHAPTER

This chapter includes the following sections:

- [Overview on page 1312](#)
- [Route Redistribution on page 1318](#)
- [Configuring IS-IS on page 1320](#)
- [Displaying IS-IS Information on page 1325](#)
- [Managing IS-IS on page 1326](#)
- [Configuration Example on page 1332](#)



NOTE

The IS-IS feature is supported only at and above the license level listed for this feature in the license tables in [Appendix A, “Feature License Requirements.”](#)

This chapter assumes that you are already familiar with Intermediate System-Intermediate System (IS-IS) and IP routing. If not, refer to the following publications for additional information:

- RFC 1195—*Use of OSI IS-IS for Routing in TCP/IP and Dual Environments*
- RFC 2763—*Dynamic Hostname Exchange Mechanism for IS-IS*
- RFC 2966—*Domain-Wide Prefix Distribution with Two-Level IS-IS*
- RFC 2973—*IS-IS Mesh Groups*
- RFC 3373—*Three-Way Handshaking for IS-IS Point-to-Point Adjacencies*
- RFC 3719—*Recommendations for Interoperable Networks using Intermediate System to Intermediate System (IS-IS)*
- RFC 3787—*Recommendations for Interoperable IP Networks using Intermediate System to Intermediate System (IS-IS)*
- draft-ietf-isis-ipv6-06—*Routing IPv6 with IS-IS*
- draft-ietf-isis-restart-02—*Restart signaling for IS-IS*
- draft-ietf-isis-wg-multi-topology-11—*Multi-topology (MT) routing in IS-IS*
- ISO 10589—*OSI IS-IS Intra-Domain Routing Protocol* (also available as RFC 1142)
- *Interconnections: Bridges and Routers*
by Radia Perlman
ISBN 0-201-56332-0
Published by Addison-Wesley Publishing Company

Overview

IS-IS is a link state protocol that distributes routing information between routers belonging to a single IP domain; the IP domain is also known as an autonomous system (AS). In a link-state routing protocol, each router maintains a database describing the topology of the AS. Each participating router has an identical database maintained from the perspective of that router.

From the link state database (LSDB), each router constructs a tree of shortest paths, using itself as the root. The shortest path tree provides the route to each destination in the AS. When several equal-cost routes to a destination exist, traffic can be distributed among them. The cost of a route is described by a single metric.

IS-IS is an interior gateway protocol (IGP), as are RIP and OSPF. Unlike RIP and OSPF, IS-IS was not initially designed for IP. RFC 1195 specifies how IS-IS can run in an IP environment. The Extreme Networks implementation supports IS-IS only in IP environments. RIP, OSPF, and IS-IS are compared in [Chapter 33, “RIP.”](#) The IPv6 versions of these protocols are compared in [Chapter 34, “RIPng.”](#)

The following sections introduce some of the components of the IS-IS feature implementation:

- [Establishing Adjacencies on page 1312](#)
- [IS-IS Hierarchy on page 1315](#)
- [IS-IS and IP Routing on page 1316](#)
- [Authentication on page 1316](#)
- [Dynamic Hostname on page 1316](#)
- [Route Leaking on page 1317](#)
- [Metric Types on page 1317](#)
- [IS-IS Restart on page 1317](#)
- [IPv4 and IPv6 Topology Modes on page 1317](#)

Establishing Adjacencies

An adjacency is an acknowledged relationship between two IS-IS routers. An adjacency must be established before two IS-IS routers can exchange routing information.

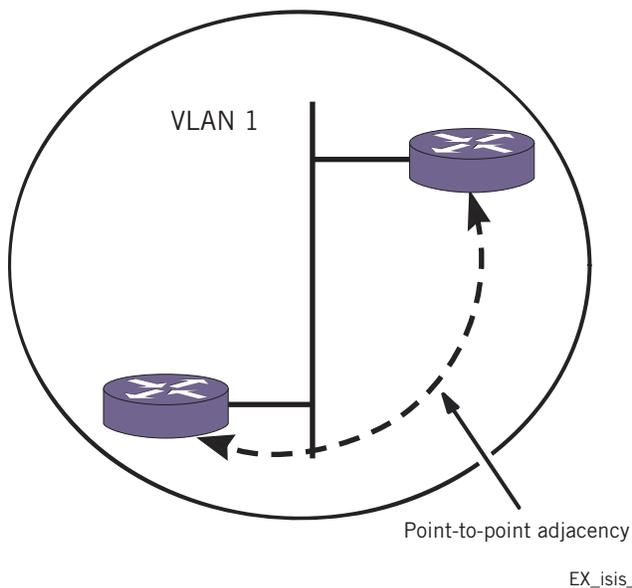
IS-IS routers establish adjacencies by exchanging hello PDUs, which are also called Intermediate System to Intermediate System Hellos (IIHs). Hello PDUs contain some interface configuration and capability information. Once a pair of neighbors exchanges hello PDUs with acceptably matching configuration and capabilities, an adjacency is formed. Hello PDUs are sent periodically by each party to maintain the adjacency.

After an adjacency is formed, information about the adjacency is stored in a link state PDU (LSP), which is stored in the router link state database (LSDB). Routers periodically flood all of their LSPs to all other network nodes. When a router receives LSPs, it adds the LSPs to its LSDB, and uses the LSDB to calculate routes to other routers. These database maintenance operations are performed a little differently for the two adjacency types, *point-to-point* and *broadcast*.

Point-to-Point Adjacency

Point-to-point adjacencies can include no more than two routers in the same VLAN. [Figure 214](#) shows a point-to-point adjacency.

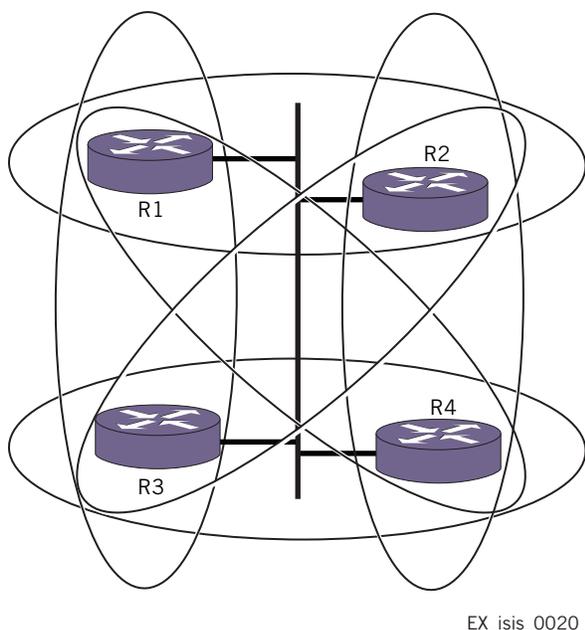
Figure 211: Point-to-Point Adjacency



Once a point-to-point adjacency is established, each router sends a CSNP (Complete Sequence Number PDU) listing a summary of all its LSPs. When a router receives its neighbor's CSNP, it sends any LSP it has that is either not present in the CSNP or is newer than the version in the CSNP. In a point-to-point adjacency, partial sequence number PDUs (PSNPs) are used to acknowledge each LSP a router receives from its neighbor. If a PSNP is not received within a configurable period of time, unacknowledged LSPs are resent.

A disadvantage to point-to-point adjacencies is that they do not scale well. [Figure 212](#) shows a four-router network with point-to-point adjacencies.

Figure 212: Point-to-Point Adjacencies in a Four-Router Network

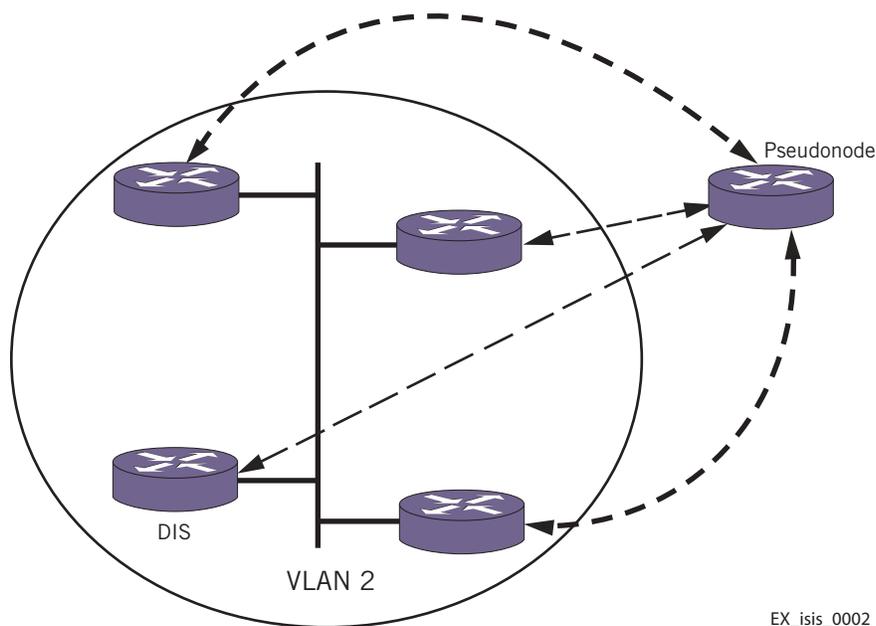


In the network in [Figure 212](#), each of the ellipses represents a point-to-point adjacency. Each of the four routers periodically sends all of its LSPs to the other three routers. Each, in turn, will flood the received LSPs to the other two since they have no way of knowing which routers have already received them, generating N^2 LSPs. This network routing traffic reduces the bandwidth available for data traffic. For networks that only have two routers and are not likely to grow, a point-to-point adjacency is appropriate.

Broadcast Adjacency

Broadcast adjacencies can include two or more routers in a single adjacency. [Figure 213](#) depicts a broadcast adjacency.

Figure 213: Broadcast Adjacencies in a Four-Router Network



EX_isis_0002

When broadcast adjacencies are formed, one of the routers participating in the adjacency is elected *designated intermediate system* (DIS). The election is determined by a DIS priority configured for each router. In the event of a tie, the router with the numerically highest MAC address wins.

A broadcast network can be considered a virtual node, or pseudonode, to which all routers have a zero-cost adjacency.

The DIS acts on behalf of the pseudonode by advertising an LSP listing all routers in the adjacency with zero-cost metric. The DIS also periodically sends a complete sequence number PDU (CSNP), which lists all LSPs in the link-state database. If a router sees that it is missing one or more of the entries, it multicasts a request for them using a PSNP. Only the DIS responds to this request by sending the requested LSPs. All routers multicast their originated LSPs as they are refreshed, and multicast periodic hellos to the network.

The default configuration creates broadcast adjacencies.

IS-IS and IP Routing

IS-IS is not inherently an IP Routing protocol. Its control packets do not use IP. RFC 1195 specifies the use of IS-IS for IP Routing.

The ExtremeXOS software implementation of IS-IS requires that at least one IPv4 or IPv6 address be assigned to an interface.

IP addresses and subnets can be assigned independent of area structure provided that neighboring interfaces are on the same subnet. L1 routers exchange directly reachable IP address/mask/metric tuples. When routing in an L1 area, packets are routed via L1 if the destination address is reachable within the area. Otherwise packets are forwarded to the nearest L2 router. L2 routers advertise all IP addresses reachable in their L1 area (if they are a member of one) as well as directly reachable addresses.

Summary Addresses

Routers can be manually configured to advertise abbreviated versions of reachable addresses, which are called *summary addresses*. By aggregating many routes into one summary address, route computation and lookup can be made more efficient. If packets arrive at the router as a result of the summary address but have no actual route (as a result of the summary address covering more address space than is actually used), the packets are discarded.

For instructions on managing summary addresses, see [“Managing IP Summary Addresses” on page 1328](#).

External Connectivity

Externally reachable IP addresses are those learned or exported from other routing protocols like RIP, BGP, and OSPF.

When using narrow metrics, external routes may use internal or external metrics. When calculating SPF, routes with internal metrics are preferred over routes with external metrics. When external metrics are used to compare routes, the internal cost is not considered unless the external metrics are equal.

Authentication

Entire packets (as opposed to individual TLVs in a packet) can be authenticated. If authentication fails on a packet, the entire packet is discarded. Multi-part packets are authenticated separately. Routers are not required to support authentication. The ExtremeXOS software provides optional support for plain-text authentication.

Dynamic Hostname

The dynamic hostname exchange extension helps address the usability issues of maintaining IS-IS routers. IS-IS system IDs (which default to the switch MAC address) are not very readable. When the dynamic hostname feature is enabled, learned IS-IS hostnames are used in place of system IDs in log entries where possible. In addition, hostname TLVs appear in the `show isis lsdb detail` command display.

For instructions on managing the dynamic hostname feature, see [“Configuring the Dynamic Hostname Feature” on page 1324](#).

Route Leaking

Route leaking allows L2 LSPs to be sent into L1 areas.

Route-leaking is configured with the `configure isis area <area_name> interlevel-filter level 2-to-1 [<policy> | block-all | allow-all] {ipv4 | ipv6}` command. The supplied policy defines what route or routes should be leaked.



CAUTION

Route leaking can reduce scalability and performance.

Metric Types

Interface metrics are available in two sizes: a 6-bit *narrow* metric and a 24-bit *wide* metric. By default only narrow metrics are used. Wide metrics allow for greater flexibility, however, and are required in order to use some extensions of IS-IS, such as IPv6. All routers in an IS-IS area must use the same metric style.

For instructions on configuring interface metric style and values, see “[Configuring VLAN Interface Metrics](#)” on page 1330. Refer to RFC 3787, Section 5.1, for migration details. Note that the ExtremeXOS software does not support section 5.2.

IS-IS Restart

When an IS-IS router restarts, neighbors time adjacencies out and the network converges around it. IS-IS restart support, with the help of restart helper neighbors, can prevent this. A restarting router can send a restart request to indicate to its neighbors that it is restarting. Neighbors—provided they are helpers—send the restarting router a CSNP so that it can reconstruct its LSDB by tracking which LSPs it has and has not received. Neighbors can still time the adjacency out, so this might not work in environments with low hold timers.

IS-IS restart can be configured for planned and unplanned events. Planned events are user-initiated process restarts and user-initiated failovers. Unplanned events are process restarts or failovers that are not administratively initiated. For information on configuring IS-IS restart, see “[Configuring the Graceful Restart Feature](#)” on page 1323.

IPv4 and IPv6 Topology Modes

Interfaces can be IS-IS-enabled for IPv4, IPv6, or both. Within an IS-IS area, IPv4 and IPv6 can be supported in a *single* topology or in a *multiple* topology. A *transition* configuration is provide for migrating between the single and multiple topologies.

In a *single* topology, all interfaces in an area must be configured for IPv4, IPv6, or both IPv4 and IPv6. Adjacencies are denied if the topology configuration between two routers does not match. A single SPF calculation is performed for each route in a single topology area.

In a *multiple* topology area, each interface can be configured for IPv4, IPv6, or both IPv4 and IPv6. The router creates separate topologies for IPv4 and IPv6. Adjacencies are permitted between interfaces with different configurations, provided that the neighbors support at least one common protocol. Separate SPF calculations are computed for IPv4 and IPv6 routes.

**NOTE**

Although the IPv4 and IPv6 topologies can be different when multiple topologies are enabled, the topologies must be convex. That is, no IPv4 interface can be reachable only through traversal of IPv6 interfaces, and vice versa. All routers in an area must use the same topology mode.

When the *transition* topology mode is configured, the router allows adjacencies between any two interfaces, and distributes both single topology and multiple topology TLVs. Transition mode permits both single and multiple topologies to coexist, but it generates more traffic. Transition mode should be used only for transitioning between modes and should be disabled after the transition is complete.

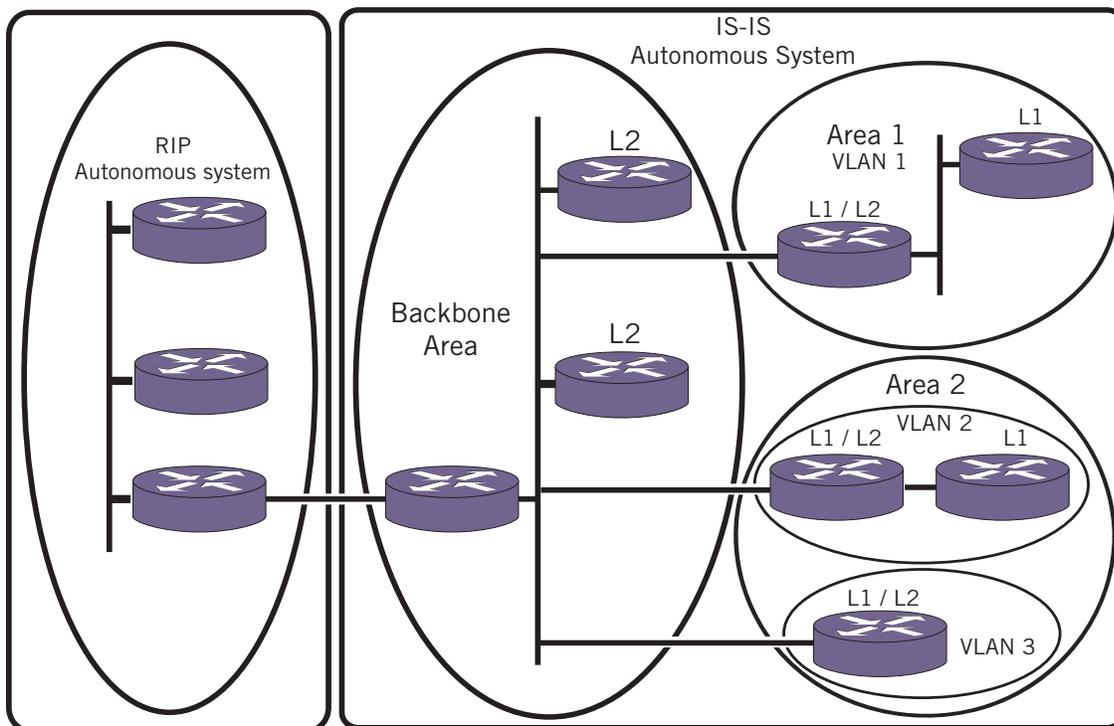
By default, a single topology is used for both IPv4 and IPv6. As a result, all interfaces must be homogeneously ISIS-enabled for IPv4, IPv6, or both.

To change the configured topology mode, see “[Configuring the Multi-Topology Feature](#)” on page 1325.

Route Redistribution

More than one routing protocol can be enabled simultaneously on a network. Route redistribution allows the switch to exchange routes, including static routes, between the active routing protocols. [Figure 215](#) shows a network that is running two routing protocols, IS-IS and RIP.

Figure 215: AS External Route Redistribution



EX_isis_0024

By default, the ISIS/RIP node does not inject its learned RIP routes into ISIS (and it does not need to if `originate-default` feature is enabled—`enable isis area <area_name> originate-default {ipv4 |`

`ipv6}` command). If it does redistribute the RIP routes into ISIS, all L2 ISIS routers learn the RIP routes as type *isis level 2 external*. The L2 ISIS routers do not know that the routes actually originated from RIP. Also, if configured to do so, L1/L2 routers can leak these routes into the L1 areas and all ISIS routers learn the RIP routes (without knowing that they actually came from RIP and without having to actually participate in RIP).

Route redistribution is configurable on both L2 and L1 using the `enable isis area export` commands. Redistributing routes into L1 generates L1 external routes. The export policy can choose to redistribute external routes with internal metrics into IS-IS.

Configuring Route Redistribution

Exporting routes from one protocol to another and in the reverse direction are discrete configuration functions. For example, to run IS-IS and RIP simultaneously, you must first configure both protocols and then verify the independent operation of each. Then you can configure the routes to export from IS-IS to RIP and the routes to export from RIP to IS-IS. Likewise, for any other combinations of protocols, you must separately configure each to export routes to the other.

This section describes how to inject routing information learned from other IP routing protocols into an IS-IS domain, thereby advertising their reachability in the IS-IS domain. These routes are included in the locally originated LSPs. For information on exporting routes learned in IS-IS to another routing protocol, see the chapter that describes the destination routing protocol.

When you export routes from another protocol to IS-IS, the metric and the type of metric are configured. You can also configure a policy to filter out unwanted external routes.

To enable or disable the exporting of BGP, OSPF, RIP, static, and direct (interface) IPv4 routes to IS-IS, use the following commands:

```
enable isis area <area_name> export {ipv4} <route-type> [<policy> | metric <mvalue>
{metric-type [internal | external]]] {level [1 | 2 | both-1-and-2]}
```

```
disable isis area <area_name> export {ipv4} <route-type>
```

To enable or disable the exporting of OSPFv3, RIPng, static, and direct (interface) IPv6 routes to IS-IS, use the following commands:

```
enable isis area <area_name> export ipv6 <route-type> [<policy> | metric <mvalue>]
{level [1 | 2 | both-1-and-2]}
```

```
disable isis area <area_name> export ipv6 <route-type>
```

The cost metric is inserted for all OSPF, RIP, static, and direct routes injected into IS-IS.

The same cost and type values can be inserted for all the export routes, or policies can be used for selective insertion. When a policy is associated with the export command, the policy is applied on every exported route. The exported routes can also be filtered using policies.

Verify the configuration using the command:

```
show isis area [<area_name> | all]
```

Configuring IS-IS

This section describes the following tasks:

- [Configuring L1 Routers on page 1320](#)
- [Configuring L1/L2 Routers on page 1321](#)
- [Configuring L2 Routers on page 1322](#)
- [Configuring IS-IS Timers on page 1322](#)
- [Configuring the Graceful Restart Feature on page 1323](#)
- [Configuring Hello Padding on page 1323](#)
- [Configuring Interlevel Filters on page 1324](#)
- [Configuring the Dynamic Hostname Feature on page 1324](#)
- [Configuring the Adjacency Check Feature on page 1324](#)
- [Configuring an Import Policy on page 1325](#)
- [Configuring the Multi-Topology Feature on page 1325](#)

Configuring L1 Routers

To configure a switch to operate as a level 1 IS-IS router, do the following:

- 1 Prepare the IP interfaces that will support level 1 IS-IS routing as follows:
 - a Add an IPv4 or IPv6 address.
 - b Enable IP or IPv6 forwarding.
- 2 Create the IS-IS routing process, which is also called an *area*, using the following command:

```
create isis area <area_name>
```
- 3 Configure the routing process to serve as a L1-only router using the following command:

```
configure isis area <area_name> is-type level [1 | 2 | both-1-and-2]
```

Specify 1 for the level option.
- 4 Add an IS-IS area level-1 address to the router using the following command:

```
configure isis area <area_name> add area-address <area_address>
```
- 5 Add IS-IS-eligible interfaces to the area using the following command:

```
configure isis add [vlan all | {vlan} <vlan_name>] area <area_name> {ipv4 | ipv6}
```

An IS-IS-eligible interface is one that already has the appropriate IP address type (IPv4 or IPv6) address assigned to it.
- 6 The default IS-IS system ID is the switch MAC address. If you want to change the default IS-IS system ID, use the following command:

```
configure isis area <area_name> system-id [automatic | <system_id>]
```
- 7 Enable the IS-IS router using the following command:

```
enable isis {area <area_name>}
```

Configuring L1/L2 Routers

To configure a switch to operate as a L1/L2 IS-IS router, do the following:

- 1 Prepare the IP interfaces that will support level 1 IS-IS routing as follows:
 - a Add an IPv4 or IPv6 address.
 - b Enable IP or IPv6 forwarding.
- 2 Create the IS-IS routing process, which is also called an *area*, using the following command:


```
create isis area <area_name>
```
- 3 Configure the routing process to serve as an L1/L2 router using the following command:


```
configure isis area <area_name> is-type level [1 | 2 | both-1-and-2]
```

 Specify `both-1-and-2` for the level option.



NOTE

When no other L2 processes are defined on the router, the default IS type level is L1/L2, and this command can be omitted.

- 4 Add an IS-IS area level-1 address to the router using the following command:


```
configure isis area <area_name> add area-address <area_address>
```
- 5 Add an IS-IS area level-2 address to the router using the following command:


```
configure isis area <area_name> add area-address <area_address>
```
- 6 Add IS-IS-eligible interfaces to the area using the following command:


```
configure isis add [vlan all | {vlan} <vlan_name>] area <area_name> {ipv4 | ipv6}
```

 An IS-IS-eligible interface is one that already has the appropriate IP address type (IPv4 or IPv6) address assigned to it.
- 7 If your topology requires interfaces to operate at a specific topology level, configure the appropriate interfaces with the following command:


```
configure isis [vlan all | {vlan} <vlan_name>] circuit-type level [1 | 2 | both-1-and-2]
```
- 8 The default IS-IS system ID is the switch MAC address. If you want to change the default IS-IS system ID, use the following command:


```
configure isis area <area_name> system-id [automatic | <system_id>]
```



NOTE

Although the IS-IS protocols manage IP routing, they use the Connectionless Network Protocol (CLNP) for IS-IS communications between routers. The IS-IS system ID is required to identify the router in the AS.

- 9 Enable the IS-IS router using the following command:


```
enable isis {area <area_name>}
```

Configuring L2 Routers

To configure a switch to operate as a level 2 IS-IS router, do the following:

- 1 Prepare the IP interfaces that will support level 2 IS-IS routing as follows:
 - a Add an IPv4 or IPv6 address.
 - b Enable IP or IPv6 forwarding.
- 2 Create the IS-IS routing process, which is also called an *area*, using the following command:


```
create isis area <area_name>
```
- 3 Configure the routing process to serve as a L2-only router using the following command:


```
configure isis area <area_name> is-type level [1 | 2 | both-1-and-2]
```

 Specify 2 for the level option.
- 4 Add an IS-IS area level-2 address to the router using the following command:


```
configure isis area <area_name> add area-address <area_address>
```
- 5 Add IS-IS-eligible interfaces to level 2 using the following command:


```
configure isis add [vlan all | {vlan} <vlan_name>] area <area_name> {ipv4 | ipv6}
```

 An IS-IS-eligible interface is one that already has the appropriate IP address type (IPv4 or IPv6) address assigned to it.
- 6 Add an IS-IS system ID to the router using the following command:


```
configure isis area <area_name> system-id [automatic | <system_id>]
```

 Use the `automatic` option to assign the switch MAC address to the IS-IS system ID. The default option is `automatic`, so you can also enter the command without options to select the switch MAC address.
- 7 Enable the ISIS router using the following command:


```
enable isis {area <area_name>}
```

Configuring IS-IS Timers

IS-IS timers allow you to fine tune IS-IS operation. [Table 133](#) lists the IS-IS timers and the command you can use to adjust them.

Table 133: IS-IS Configuration Timers and Commands

Timer	Command
T1 hello restart interval	<pre>configure isis [vlan all {vlan} <vlan_name>] timer restart-hello-interval <seconds> {level [1 2]}</pre>
T2 restart timer	<pre>configure isis area <area_name> timer restart <seconds> {level [1 2]}</pre>
T3 restart grace period	<pre>configure isis restart grace-period <seconds></pre>
LSP generation interval	<pre>configure isis area <area_name> timer lsp-gen-interval <seconds> {level [1 2]}</pre>
LSP maximum lifetime	<pre>configure isis area <area_name> timer max-lsp-lifetime <seconds></pre>
LSP refresh interval	<pre>configure isis area <area_name> timer lsp-refresh-interval <seconds></pre>
SPF interval	<pre>configure isis area <area_name> timer spf-interval <seconds> {level [1 2]}</pre>

Table 133: IS-IS Configuration Timers and Commands (Continued)

Timer	Command
CSNP interval	<code>configure isis [vlan all {vlan} <vlan_name>] timer csnp-interval <seconds> {level [1 2]}</code>
Hello interval	<code>configure isis [vlan all {vlan} <vlan_name>] timer hello-interval [<seconds> minimal] {level [1 2]}</code>
Hello multiplier	<code>configure isis [vlan all {vlan} <vlan_name>] hello-multiplier <multiplier> {level [1 2]}</code>
LSP retransmit interval	<code>configure isis [vlan all {vlan} <vlan_name>] timer retransmit-interval <seconds></code>
LSP transmit interval	<code>configure isis [vlan all {vlan} <vlan_name>] timer lsp-interval <milliseconds></code>

Configuring the Graceful Restart Feature

The graceful restart feature enables a router process to restart with minimal impact on the network. Without graceful restart, every other IS-IS router in the network must update its LSDB when the router goes down, and this generates a lot of traffic, and it introduces delays while new routes are established. With graceful restart, the router process requests restart support from its neighbors, and the neighbors wait for a predefined time before declaring routes dead. If the restart completes before the predefined time ends, the restart causes minimal impact on the network operation. For more information on graceful restart, see [“IS-IS Restart” on page 1317](#).

To enable or disable the graceful restart feature, use the following commands:

```
enable isis restart-helper
```

```
disable isis restart-helper
```

To configure which events trigger a graceful restart, use the following command:

```
configure isis restart [ none | planned | unplanned | both ]
```

To configure the timers used to control graceful restart operation, use the commands in [Table 134](#).

Table 134: Timers that Control Graceful Restart

Timer	Configuration Command
T1 restart hello interval	<code>configure isis [vlan all {vlan} <vlan_name>] timer restart-hello-interval <seconds> {level [1 2]}</code>
T2 restart timer	<code>configure isis area <area_name> timer restart <seconds> {level [1 2]}</code>
T3 restart grace period	<code>configure isis restart grace-period <seconds></code>
Hello interval	<code>configure isis [vlan all {vlan} <vlan_name>] timer hello-interval [<seconds> minimal] {level [1 2]}</code>
Hello multiplier	<code>configure isis [vlan all {vlan} <vlan_name>] hello-multiplier <multiplier> {level [1 2]}</code>

Configuring Hello Padding

Hello PDUs are padded to the MTU by default, and this is called *hello padding*. This is to help identify and correct cases where switches have mismatched MTUs. Because IS-IS packets cannot be fragmented

in transit, maintaining consistent MTUs is important to ensure the reliability of packets traversing the network. However, this extra padding could be a waste of bandwidth in scenarios where the MTU is fixed throughout the network.

To disable hello padding, use the following command:

```
disable isis [vlan all | {vlan} <vlan_name>] hello-padding
```

To enable hello padding, use the following command:

```
enable isis [vlan all | {vlan} <vlan_name>] hello-padding
```

Configuring Interlevel Filters

Interlevel filters allow you to control how routes are redistributed between IS-IS levels 1 and 2. The redistribution of routes from level 2 to level 1 is called *route leaking*. For more information on route leaking, see “[Route Leaking](#)” on page 1317.

To set an interlevel filter for redistribution from level 1 to level 2, use the following command:

```
configure isis area <area_name> interlevel-filter level 1-to-2 [<policy> | none] {ipv4  
| ipv6}
```

To set an interlevel filter for redistribution from level 2 to level 1, use the following command:

```
configure isis area <area_name> interlevel-filter level 2-to-1 [<policy> | block-all |  
allow-all] {ipv4 | ipv6}
```

Configuring the Dynamic Hostname Feature

“[Dynamic Hostname](#)” on page 1316 introduces the dynamic hostname feature, which causes text names to replace numbers in some logs.

To enable the dynamic hostname feature, use the following command:

```
enable isis area <area_name> dynamic-hostname [area-name | snmp-name]
```

To disable the dynamic hostname feature, use the following command:

```
disable isis area <area_name> dynamic-hostname
```

Configuring the Adjacency Check Feature

When enabled, the adjacency check feature permits an adjacency between two IS-IS interfaces only when both interfaces are configured for the same IP address type (IPv4 or IPv6) and are configured for the same subnet.

To enable the adjacency check feature, use the following command:

```
enable isis area <area_name> adjacency-check {ipv4 | ipv6}
```

To disable the adjacency check feature, use the following command:

```
disable isis area <area_name> adjacency-check {ipv4 | ipv6}
```

Configuring an Import Policy

When applied to a router process, an import policy controls how routes are imported to the FIB from all IS-IS processes on this virtual router.

To apply a policy to a router process, use the following command:

```
configure isis import-policy [<policy-map> | none]
```



NOTE

The import policy cannot be used to select which routes are added to the routing table. The import policy can only modify the route attributes as routes are added to the routing table.

Configuring the Multi-Topology Feature

The multi-topology feature is introduced in “IPv4 and IPv6 Topology Modes” on page 1317.

To configure the multi topology feature, use the following command:

```
configure isis area <area_name> topology-mode [single | multi | transition] {level [1 | 2]}
```

Displaying IS-IS Information

This section describes the following tasks:

- [Displaying General Information for Global IS-IS on page 1325](#)
- [Displaying Router-Specific Information on page 1325](#)
- [Displaying Router Summary Addresses on page 1326](#)
- [Displaying IS-IS Interface Information on page 1326](#)
- [Displaying Link State Database Information on page 1326](#)
- [Displaying IPv4 and IPv6 Topology Information on page 1326](#)
- [Displaying IS-IS Neighbors on page 1326](#)
- [Displaying IS-IS Counter Data on page 1326](#)

Displaying General Information for Global IS-IS

To display general information for global IS-IS, use the following command:

```
show isis
```

Displaying Router-Specific Information

To display router-specific information, use the following command:

```
show isis area [<area_name> | all]
```

Displaying Router Summary Addresses

To display router summary addresses, use the following command:

```
show isis area <area_name> summary-addresses
```

Displaying IS-IS Interface Information

To display IS-IS interface information, use the following command:

```
show isis vlan {enabled | { <vlan_name> | all} }
```

Displaying Link State Database Information

To display link state database information, use the following command:

```
show isis lsdb {area <area_name> {lsp-id <lsp_id>}} {level [1|2]} {detail | stats}
```

Displaying IPv4 and IPv6 Topology Information

To display IPv4 and IPv6 topology information, use the following command:

```
show isis topology {area <area_name> {level [1 | 2]}} {ipv4 | ipv6}
```

Displaying IS-IS Neighbors

To display IS-IS neighbor information, use the following command:

```
show isis neighbors {area <area_name>} {vlan <vlan_name>} {ipv4 | ipv6} {detail}
```

Displaying IS-IS Counter Data

To display IS-IS counter data, use the following command:

```
show isis counters {area [<area-name> | all] | vlan [<vlan-name> | all]}
```

Managing IS-IS

This section describes the following tasks:

- [Configuring Password Security on page 1327](#)
- [Managing Transit Traffic with the Overload Bit on page 1327](#)
- [Clearing the IS-IS Counters on page 1328](#)
- [Originating an L2 Default Route on page 1328](#)
- [Managing IP Summary Addresses on page 1328](#)
- [Managing an IS-IS Area Address on page 1329](#)
- [Managing VLAN Interfaces on page 1329](#)
- [Managing IS-IS Routers on page 1331](#)

Configuring Password Security

The ExtremeXOS software supports passwords for the following IS-IS AS components:

- Level 2 domains
- Level 1 areas
- VLAN interfaces

Domain and area authentication prevents intruders from injecting invalid routing information into the router. Because passwords must be configured to match at both ends of a connection, password security also helps detect unconfigured and misconfigured interfaces. After configuration, the password is inserted into LSP, CSNP, and PSNP PDUs and validated on the receiving end.



NOTE

The password configuration commands in this section provide an encrypted option, which controls how the passwords are saved and displayed on the switch. The encrypted option does not encrypt messages that are transmitted on the network. All passwords are transmitted in clear text.

To configure password security for a level 2 domain, use the following command:

```
configure isis area <area_name> domain-password [none | {encrypted} simple <password>
{authenticate-snp {tx-only}}]
```

To configure password security for a level 1 area, use the following command:

```
configure isis area <area_name> area-password [none | {encrypted} simple <password>
{authenticate-snp {tx-only}}]
```

Interface authentication prevents unauthorized routers from forming an adjacency. This is achieved by inserting a password in hello PDUs and validating the password on the receiving end. You can configure password protection separately for level 1 and level 2.

To configure password security for a VLAN interface, use the following command:

```
configure isis [vlan all | {vlan} <vlan_name>] password [none | {encrypted} simple
<password>] level [1 | 2]
```

Managing Transit Traffic with the Overload Bit

If a router lacks the resources to maintain a complete link state database, routing packets to it could result in a blackhole or routing loop. The overload bit prevents this undesirable behavior by indicating to the other routers that the afflicted router should not be used as a transit router. Packets destined for directly attached routes can still be routed to a router with the overload bit set, but all other routing paths reconverge around it.

To manually enable the overload bit feature, enter the following command:

```
enable isis area <area_name> overload-bit {suppress [external | interlevel | all]}
```

To configure the router to automatically set the overload bit on startup, enter the following command:

```
configure isis area <area_name> overload-bit on-startup [ off | {suppress [external |
interlevel | all]} <seconds>]
```

To disable the overload bit feature, use the following commands:

```
disable isis area <area_name> overload-bit
```



NOTE

Enabling or disabling the overload bit feature does not modify the configuration of the `configure isis area <area_name> overload-bit on-startup [off | {suppress [external | interlevel | all]} <seconds>]` command.

Clearing the IS-IS Counters

The `show isis counters {area [<area-name> | all] | vlan [<vlan-name> | all]}` command can display all counters or only those specific to the router process or the configured VLANs.

To clear the IS-IS counters for the router and the VLANs, enter the following command:

```
clear isis counters
```

To clear the IS-IS counters only for the router process, enter the following command:

```
clear isis counters area [<area_name> | all]
```

To clear the IS-IS counters only for one or all VLANs, enter the following command:

```
clear isis counters [vlan all | {vlan} <vlan_name>]
```

Originating an L2 Default Route

This feature injects a zero-cost route to 0.0.0.0 in LSPs originated by an L2 router, thereby advertising the router as the default gateway.

To enable default route origination, use the command:

```
enable isis area <area_name> originate-default {ipv4 | ipv6}
```

To disable default route origination, use the command:

```
disable isis area <area_name> originate-default {ipv4 | ipv6}
```

Managing IP Summary Addresses

Summary addresses are introduced in “[Summary Addresses](#)” on page 1316. L2 routers include in their L2 LSPs a list of all destinations reachable in the L1 area attached to them by default. Summarization of the L1 destinations reduces the amount of information stored on each L2 router and helps in scaling to a large routing domain.

To add summary addresses to an IS-IS router, use the following command:

```
configure isis area <area_name> add summary-address [<ipv4_address_mask> | <ipv6_address_mask>] {level [1 | 2]}
```

To delete summary addresses from an IS-IS router, use the following command:

```
configure isis area <area_name> delete summary-address [<ipv4_address_mask> | <ipv6_address_mask>] {level [1 | 2]}
```

To display the configured summary addresses for an IS-IS router, use the following command:

```
show isis area <area_name> summary-addresses
```

Managing an IS-IS Area Address

IS-IS was not originally designed for IP routing. Some aspects of CLNP routing, such as system IDs and area addresses, exist in the IP extension of IS-IS. The IS-IS area address is required to identify the area in which the router participates.

Before you can configure the area address, you must create the IS-IS routing process, which is also called an *area*, using the following command:

```
create isis area <area_name>
```

To add an IS-IS area address to the router, use the following command:

```
configure isis area <area_name> add area-address <area_address>
```

To delete an IS-IS area address from a router, use the following command:

```
configure isis area <area_name> delete area-address <area_address>
```



NOTE

The ExtremeXOS software implementation of IS-IS supports no more than three area addresses.

Managing VLAN Interfaces

This section describes the following tasks:

- [Adding a VLAN Interface on page 1329](#)
- [Setting the VLAN Interface Link Type on page 1330](#)
- [Setting the VLAN Interface Circuit Type on page 1330](#)
- [Configuring VLAN Interface Metrics on page 1330](#)
- [Configuring the DIS Priority for Broadcast Interfaces on page 1330](#)
- [Configuring Interface Participation in a Mesh Environment on page 1331](#)
- [Resetting a VLAN Interface to the Default Values on page 1331](#)
- [Deleting a VLAN Interface on page 1331](#)

Adding a VLAN Interface

To add a VLAN interface to a router, use the following command:

```
configure isis add [vlan all | {vlan} <vlan_name>] area <area_name> {ipv4 | ipv6}
```



NOTE

The interface is not enabled separately from the area. If the area is enabled, the interface will begin transmitting hellos as soon as this command is executed, provided the interface is in forwarding mode and has active links.

Setting the VLAN Interface Link Type

The default link type is broadcast. You can change the link type to point-to-point. To set the link type, use the following command:

```
configure isis [vlan all | {vlan} <vlan_name>] link-type [broadcast | point-to-point]
```

Setting the VLAN Interface Circuit Type

The circuit type can be level 1, level 2, or both level 1 and level 2. To set the circuit type, use the following command:

```
configure isis [vlan all | {vlan} <vlan_name>] circuit-type level [1 | 2 | both-1-and-2]
```

Configuring VLAN Interface Metrics

Normally, IS-IS metrics can have values up to 63. These metrics are *narrow* metrics. IS-IS generates two type, length, and value (TLV) codings, one for an IS-IS adjacency (code, length, and value (TLV) 2) and the second for an IP prefix (TLV 128 and TLV 130). During SPF, if the total cost of the path to a destination exceeds 1023, then according to ISO/IEC 10587, the path is ignored.

To overcome these restrictions, a second pair of TLVs is available, one for IP prefixes (TLV 135) and the second for IS-IS adjacency (TLV 22). With these TLVs, IS-IS metrics can have values up to 16,777,215 and the maximum path metric allowed is 4,261,412,864. This allows more flexibility while designing a domain. These metrics are *wide* metrics.

To configure the metric style used on the router, use the following command:

```
configure isis area <area_name> metric-style [[narrow | wide] {transition}] | transition] {level [1 | 2]}
```

To configure the narrow metric used on one or all interfaces, use the following command:

```
configure isis [vlan all | {vlan} <vlan_name>] metric <metric> {level [1 | 2]}
```

To configure the wide metric used on one or all interfaces, use the following command:

```
configure isis [vlan all | {vlan} <vlan_name>] wide-metric <metric> {level [1 | 2]}
```



NOTE

Configured narrow and wide metrics for a particular interface must be identical in value while migrating from metric style narrow to metric style wide. Only if the metric style is “narrow” or “wide” (that is, no “transition”) is it okay to have different values (because one of the values is not used).

Configuring the DIS Priority for Broadcast Interfaces

The designated intermediate system (DIS) is introduced in [“Establishing Adjacencies” on page 1312](#). When you configure the DIS priority, higher priority means higher election precedence (60 gets elected before 50). To configure the DIS priority, use the following command:

```
configure isis [vlan all | {vlan} <vlan_name>] priority <priority> {level [1 | 2]}
```

**NOTE**

DIS priority 0 is the lowest priority value. Unlike an OSPF DR election, a DIS priority of 0 does not make a router ineligible for DIS election.

Configuring Interface Participation in a Mesh Environment

Fully-meshed point-to-point topologies suffer from a potentially large amount of needless LSP flooding. At the trade-off of resiliency, interfaces can be restricted from flooding received LSPs.

To configure an interface for a mesh environment, use the following command:

```
configure isis [vlan all | {vlan} <vlan_name>] mesh [block-none | block-all | block-group <group_id>]
```

To block the flooding of received LSPs altogether, use the `mesh block-all` option.

To block the flooding of LSPs received on a specific group of interfaces (which are those with the same mesh group ID), use the `mesh block-group <group_id>` option.

To remove blocking for an interface, use the `mesh block-none` option.

Resetting a VLAN Interface to the Default Values

To reset a VLAN interface to the default values, use the following command:

```
unconfigure isis [vlan all | {vlan} <vlan_name>] {level [1|2]}
```

Deleting a VLAN Interface

To delete a VLAN interface from a router, use the following command:

```
configure isis delete [vlan all | {vlan} <vlan_name>] {area <area_name>} {ipv4 | ipv6}
```

Managing IS-IS Routers

This section describes the following tasks:

- [Adding an IS-IS Router on page 1331](#)
- [Changing the IS-IS Level of a Router on page 1332](#)
- [Resetting an IS-IS Router to the Default Values on page 1332](#)
- [Restarting All IS-IS Routers in a Virtual Router on page 1332](#)
- [Disabling an IS-IS Router on page 1332](#)
- [Deleting an IS-IS Router on page 1332](#)

Adding an IS-IS Router

To add an IS-IS router, use the following command:

```
create isis area <area_name>
```

Changing the IS-IS Level of a Router

To change the IS-IS level of a router, use the following command:

```
configure isis area <area_name> is-type level [1 | 2 | both-1-and-2]
```

Resetting an IS-IS Router to the Default Values

To reset an IS-IS router to the default values, use the following command:

```
unconfigure isis area <area_name> {level [1|2]}
```

Restarting All IS-IS Routers in a Virtual Router

To restart all IS-IS routers in a virtual router, use the following command and specify the IS-IS process:

```
restart process [class <cname> | <name> {msm <slot>}]
```

For example:

```
restart process isis
```

Disabling an IS-IS Router

To disable an IS-IS router, use the following command:

```
disable isis {area <area_name>}
```

Deleting an IS-IS Router

To delete an IS-IS router, use the following command:

```
delete isis area [all | <area_name>]
```

Configuration Example

The following example shows the commands that configure an IS-IS router. Some commands apply to IPv4 or IPv6 and are labeled accordingly. Comments in parenthesis identify commands that apply to specific applications.

```
create vlan v1
configure default delete ports 1
configure v1 add ports 1

IPv4:
configure v1 ipaddress 10.0.0.1/24
enable ipforwarding v1
IPv6:
configure v1 ipaddress fe80::204:96ff:fe20:b40a/128
enable ipforwarding ipv6 v1
```

```
create isis area a1
configure isis area a1 add area-address 01.0101.0202.0303.0404.0505.0606
configure isis area a1 system-id 11aa.22bb.33cc
configure isis area a1 is-type level 1 (For Level 1 Router)
configure isis area a1 is-type level 2 (For Level 2 Router)
configure isis area a1 is-type level both-1-and-2 (For Level 1/2 Router)
configure isis area a1 metric-style wide
```

IPv4 Mapping:

```
configure isis add vlan v1 area a1
```

IPv6 Mapping:

```
configure isis add vlan v1 area a1 ipv6
```

```
enable isis area a1 (or) enable isis
```


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CHAPTER

BGP

This chapter includes the following sections:

- [Overview on page 1335](#)
- [Configuring BGP on page 1353](#)
- [Managing BGP on page 1364](#)
- [Displaying BGP Information on page 1365](#)
- [Configuration Examples on page 1366](#)

Overview

Border gateway protocol (BGP) is an exterior routing protocol that was developed for use in TCP/IP networks. The primary function of BGP is to allow different autonomous systems (ASs) to exchange network reachability information.

An AS is a set of routers that are under a single technical administration. This set of routers uses a different routing protocol, for example Open Shortest Path First (OSPF), for intra-AS routing. One or more routers in the AS are configured to be border routers, exchanging information with other border routers (in different ASs) on behalf of all of the intra-routers.

BGP can be used as an exterior border gateway protocol (referred to as EBGp), or it can be used within an AS as an interior border gateway protocol (referred to as IBGP).

The following sections provide information on BGP operation and features:

- [BGP Four-Byte AS Numbers on page 1337](#)
- [BGP Attributes on page 1337](#)
- [BGP Community Attributes on page 1338](#)
- [Extended Community Attributes on page 1338](#)
- [Multiprotocol BGP on page 1342](#)
- [Route Reflectors on page 1342](#)
- [Route Confederations on page 1343](#)
- [Inactive Route Advertisement on page 1343](#)
- [Default Route Origination and Advertisement on page 1344](#)
- [Using the Loopback Interface on page 1344](#)

- [Looped AS_Path Attribute on page 1345](#)
- [BGP Peer Groups on page 1345](#)
- [BGP Route Flap Dampening on page 1346](#)
- [BGP Route Selection on page 1346](#)
- [Private AS Number Removal from Route Updates on page 1347](#)
- [Route Redistribution on page 1347](#)
- [BGP ECMP on page 1347](#)
- [BGP Static Network on page 1348](#)
- [Graceful BGP Restart on page 1348](#)
- [Cease Subcodes on page 1349](#)
- [Fast External Fallover on page 1351](#)
- [Capability Negotiation on page 1351](#)
- [Route Refresh on page 1352](#)

For more information on BGP, refer to the following documents:

- [RFC 1745—BGP/IDRP for IP—OSPF Interaction](#)
- [RFC 1771—Border Gateway Protocol version 4 \(BGP-4\)](#)
- [RFC 1965—Autonomous System Confederations for BGP](#)
- [RFC 1966—BGP Route Reflection](#)
- [RFC 1997—BGP Communities Attribute](#)
- [RFC 2385—Protection of BGP Sessions via the TCP MD5 Signature Option](#)
- [RFC 2439—BGP Route Flap Damping](#)
- [RFC 2545—Use of BGP-4 Multiprotocol Extensions for IPv6 Inter-Domain Routing](#)
- [RFC 2796—BGP Route Reflection - An Alternative to Full Mesh IBGP](#)
- [RFC 2918—Route Refresh Capability for BGP-4](#)
- [RFC 3392—Capabilities Advertisement with BGP-4](#)
- [RFC 4271—Border Gateway Protocol 4 \(BGP-4\)](#)
- [RFC 4360—BGP Extended Communities Attribute](#)
- [RFC 4456—BGP Route Reflection: An Alternative to Full Mesh Internal BGP \(IBGP\)](#)
- [RFC 4486—Subcodes for BGP Cease Notification Message](#)
- [RFC 4724—Graceful Restart Mechanism for BGP](#)
- [RFC 4760—Multiprotocol Extensions for BGP-4](#)
- [RFC 4893—BGP Support for Four-octet AS Number Space](#)
- [RFC 5396—Textual Representation of Autonomous System \(AS\) Numbers](#)
- [draft_ietf_idr_restart_10.txt—Graceful Restart Mechanism for BGP](#)



NOTE

ExtremeXOS supports BGP version 4 only, and does not support connections to peers running older versions of BGP.

**NOTE**

For complete information about software licensing, including how to obtain and upgrade your license and what licenses are appropriate for these features, see [Appendix A, “Feature License Requirements.”](#)

BGP Four-Byte AS Numbers

The ExtremeXOS software supports 4-byte AS numbers, which can be entered and displayed in the ASPLAIN and ASDOT formats, which are described in *RFC 5396, Textual Representation of Autonomous System (AS) Numbers*.

**NOTE**

When entering an AS number in a policy file, you must enter a unique 2-byte or 4-byte AS number. The transition AS number, AS 23456, is not supported in policy files.

BGP Attributes

The following BGP attributes are supported by the switch:

- **Origin**—Defines the origin of the route. Possible values are Interior Gateway Protocol (IGP), Exterior Gateway Protocol (EGP), and incomplete.
- **AS_Path**—The list of ASs that are traversed for this route. The local AS-path is added to the BGP update packet after the policy is applied.
- **AS4_Path**—This attribute is used by 4-byte peers when sending updates to 2-byte peers. This attribute carries AS-number information that can be represented only in 4-bytes.
- **Next_hop**—The IP address of the next hop BGP router to reach the destination listed in the NLRI field.
- **Multi_Exit_Discriminator**—Used to select a particular border router in another AS when multiple border routers exist.
- **Local_Preference**—Used to advertise this router’s degree of preference to other routers within the AS.
- **Atomic_aggregate**—Indicates that the sending border router has used a route aggregate prefix in the route update.
- **Aggregator**—Identifies the BGP router AS number and router ID for the router that performed route aggregation.
- **AS4_Aggregator**: This attribute is used by 4-byte peers when sending updates to 2-byte peers. This attribute carries AS-number information that can be represented only in 4-bytes.
- **Community**—Identifies a group of destinations that share one or more common attributes.
- **Cluster_ID**—Specifies a 4-byte field used by a route reflector to recognize updates from other route reflectors in the same cluster.
- **Originator_ID**—Specifies the router ID of the originator of the route in the local AS.
- **Extended Community**—Provides a mechanism for labeling BGP-4 update messages that carry information

- Multiprotocol reachable NLRI—Used to advertise a feasible BGP route for the non IPv4-unicast address family
- Multiprotocol unreachable NLRI—This attribute is used to withdraw multiple unfeasible routes from service

BGP Community Attributes

A BGP community is a group of BGP destinations that require common handling. ExtremeXOS supports the following well-known BGP community attributes:

- no-export
- no-advertise
- no-export-subconfed

Extended Community Attributes

The extended community attribute provides a mechanism to label BGP routes. It provides two important enhancements over the standard community attribute:

- An expanded range. Extended communities are 8-bytes wide, whereas regular communities were only 4-bytes wide. So, this ensures that extended communities can be assigned for a plethora of uses, without the fear of overlap.
- The addition of a 'Type' field provides structure for the extended community

The following two types of extended communities are available:

- Route Target (RT)
- Site Of Origin (SOO)

Although these two community types are generally used in L3 VPN network setup, you can also use them in a non-L3 VPN network to control the distribution of BGP routes.

BGP does not send either the extended or standard community attributes to their neighbors by default; you must use the configuration command `configure bgp neighbor send-community`.

The following sections provide more information on extended communities:

- [Extended Community Processing on page 1338](#)
- [Associating the Extended Community Attribute to the BGP Route on page 1339](#)
- [Examples of Extended Communities on page 1340](#)
- [Extended Community Syntax on page 1340](#)
- [Extended Community Match Rule in Policy on page 1340](#)
- [Extended Community Set Rule in Policy on page 1341](#)
- [Extended Communities and BGP Route Aggregation on page 1342](#)

Extended Community Processing

When BGP receives the extended community attribute in a route from its neighbor, it validates the community syntax. If the community is syntactically valid, the inbound neighbor route-policy is applied to the route. The inbound route-policy may contain extended-community statements in match block (in other words, an `or/and` set) of the policy. If the route is not rejected by the inbound route-policy, it is

added to the LocRIB of the BGP along with the extended community. The `detail` option of the `show bgp routes` command displays the routes with the extended community attribute if they are present in that route's path attribute.

Associating the Extended Community Attribute to the BGP Route

The extended community attribute can be added to or removed from a BGP route using an ExtremeXOS policy in the same way this action is performed for a regular community attribute.

The extended-community keyword has been added in the Policy Manager, and can be used in the match as well as in the set block of a policy file. The following sections provide the syntax:

- [Syntax in Match block on page 1339](#)
- [Syntax in Set block on page 1339](#)

Syntax in Match block. `extended-community "<extended-community-1> <extended-community-2> ..."`

Where, the syntax of `<extended-community-N>` is

```
[rt|soo]:[<2-byte AS num>:<4-byte num> | <4-byte IP Address>:<2-byte num> | <4-byte AS num>L:<2-byte num> | <first two bytes of AS num>.<last two bytes of AS num>:<2-byte num>]
```

The attributes are defined as follows:

- **rt**: route target extended community type
- **soo**: site of origin extended community type
- **<2-byte AS number>**: This is a 2-byte AS number; the use of private AS-number is not recommended
- **<4-byte num>**: a 4-byte unsigned number
- **<4-byte IP address>**: a valid host IP address; a network address is not accepted; use of private IP address is not recommended; class-D IP addresses are rejected
- **<4-byte AS num>**: This is a 4-byte AS number; the use of private AS-number is not recommended
- **<first two bytes of AS num>**: This is the number represented by the first two bytes of a four-byte AS number. The use of a private AS-number is not recommended.
- **<last two bytes of AS num>**: This is the number represented by the last two bytes of a four-byte AS number. The use of a private AS-number is not recommended

Syntax in Set block. `extended-community [set | add | delete] "<extended-community-1> <extended-community-2> ..."`
`extended-community remove`

Where, the syntax of `<extended-community-N>` is the following:

```
[rt|soo]:[<2-byte AS num>:<4-byte num> | <4-byte IP Address>:<2-byte num>]
```

The attributes are defined as follows:

- **set**: Replaces the existing extended communities by the new ones as supplied in the policy statement.
- **add**: Adds new extended communities to the existing extended community attribute. If an extended community is already present, then policy will not add a duplicate extended community to the route.

- **delete**: Deletes some of the extended communities from the extended community attribute.
- **remove**: Removes extended community attribute from the route.
- **rt**: route target extended community type
- **soo**: site of origin extended community type
- **<2-byte AS number>**: This is 2-byte AS number. Use of private AS-number is not recommended
- **<4-byte num>**: 4-byte unsigned number
- **<4-byte IP address>**: A valid host IP address. Network address is not accepted. Use of private IP address is not recommended. Class-D IP address will be rejected.

Examples of Extended Communities

The following are examples of valid extended communities:

- `rt:10.203.134.56:400`
- `soo:64500:1600`
- `rt:64511:2345678`
- `soo:172.168.45.10:500`
- `rt:1.15:20000`
- `soo:65551L:50000`

The following are examples of invalid extended communities:

- `rt:10.45.87.0:600`: Invalid because the IP address is NOT a valid host IP address
- `rt:239.1.1.1:400`: Invalid because IP address belongs to class-D
- `rt:100.200.300.400:200`: Invalid because the IP address is invalid
- `soo:65536:500`: Invalid because the AS number 12345678 is out of the 2-byte AS number range, 1 to 65535

Extended Community Syntax

Please note the following details with regard to extended community syntax:

- Only `rt` and `soo` extended community types are recognized in the policy file.
- The IP address MUST be a valid host address. Network address, Class-D and experimental IP address are not accepted.
- There should not be any blank spaces inside an extended community. For example, `rt :100:200` is not a valid extended community because there are spaces between `rt` and `:`
- All three parameters of an extended community must be present, otherwise the extended community is rejected.

Extended Community Match Rule in Policy

Regular expressions are not supported for extended communities. In addition, an extended community match statement matches with a route's extended community if at least one of the extended communities in the match statement matches with the route's extended community. There is no need to for all the extended communities in a single match statement to match with the route's extended community.

For example, suppose the policy file is the following:

```
entry one {
  if {
    extended-community "rt:64500:20000 rt:10.203.134.5:40 soo:64505:50000
    soo:192.168.34.1:600";
  } then {
    permit;
  }
}
```

The above community statement will match with all BGP routes that have at least one of the following extended communities in their extended community attribute:

- rt:64500:20000
- rt:10.203.134.5:40
- soo:64505:50000
- soo:192.168.34.1:600

Extended Community Set Rule in Policy

A Policy set block can contain several extended community statements. Each set statement is applied to the matching route's extended community attribute in the top down order. That is, the first set is applied to the extended community attribute of the route, the second set is applied to the result of above, and so forth.

For example, assume that a policy is the following:

```
entry two {
  if {
    nlri 192.168.34.0/24;
  } then {
    extended-community set "rt:10.45.92.168:300";
    extended-community add "rt:10.203.100.200:40 soo:64500:60000";
    extended-community delete "rt:64505:10000 soo:72.192.34.10:70";
    permit;
  }
}
```

A BGP route 192.168.34.128/25 is received with extended community attribute rt:4567:100 soo:192.168.34.128. When the above policy entry is applied to the route's extended community attribute, the following is true:

- After applying the 1st set (community set "rt:10.45.92.168:300"), the route's community becomes rt:10.45.92.168:300.
- After applying the 2nd set (community add "rt:10.203.100.200:40 soo:64500:60000"), the community becomes rt:10.45.92.168:300 rt:10.203.100.200:40 soo:64500:60000.
- After applying the 3rd set (community delete "rt:64505:10000 soo:72.192.34.10:70"), the community becomes rt:10.45.92.168:300 rt:10.203.100.200:40 soo:64500:60000. Please note that this delete statement has no effect as none of the communities in the delete statement are present in the community attribute.

Extended Communities and BGP Route Aggregation

When BGP routes are aggregated with the `as-match` or `as-set` CLI option, all the component route's extended community attributes are aggregated and the resulting aggregated extended community attributes are attached to the aggregate network.

Aggregation of several extended community attributes is simply the set union of all the extended communities from all of the aggregated routes.

Multiprotocol BGP

Multiprotocol BGP (MBGP), which is also known as BGP4+, is an enhanced BGP that supports more than just IPv4 unicast routes. In this release, MBGP supports:

- IPv4 unicast routing and IPv4 multicast routing on all platforms.
- IPv6 unicast routing and IPv6 multicast routing on the platforms listed for this feature in [Appendix A, "Feature License Requirements."](#)

MBGP support for separate unicast and multicast routing tables allows BGP to have non-congruent topologies for unicast and multicast networks. The BGP multicast address-family routes are used by multicast protocols such as Protocol Independent Multicast (PIM) to build data distribution trees.

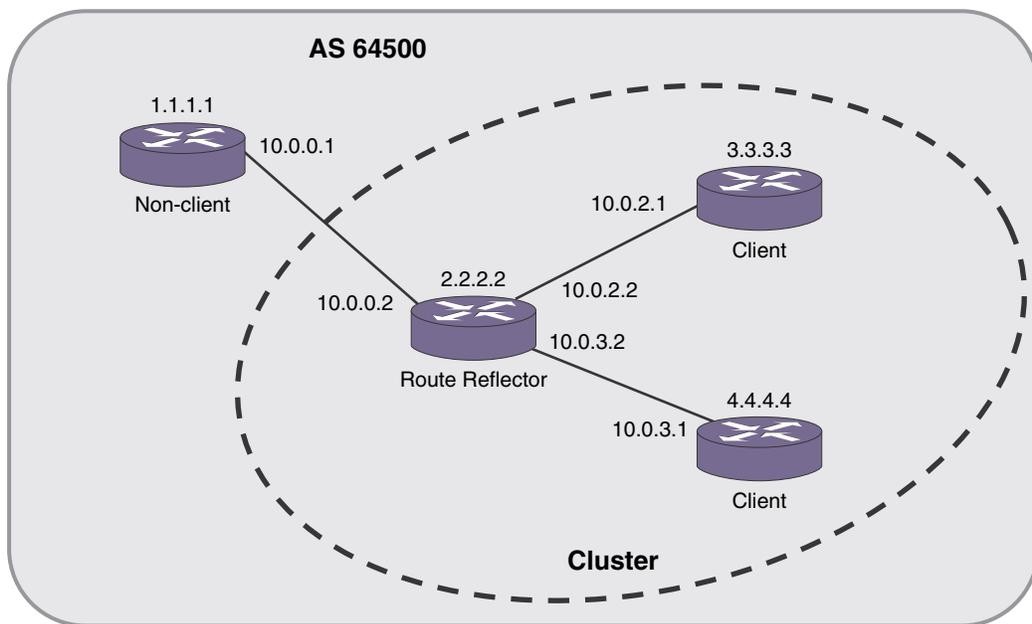
Route Reflectors

One way to overcome the difficulties of creating a fully meshed AS is to use *route reflectors*. Route reflectors allow a single router to serve as a central routing point for the AS.

A *cluster* is formed by the route reflector and its client routers. Peer routers that are not part of the cluster must be fully meshed according to the rules of BGP.

A BGP cluster, including the route reflector and its clients, is shown in [Figure 216](#).

Figure 216: Route Reflectors



The topology shown in [Figure 216](#) minimizes the number of BGP peering sessions required in an AS by using a route reflector.

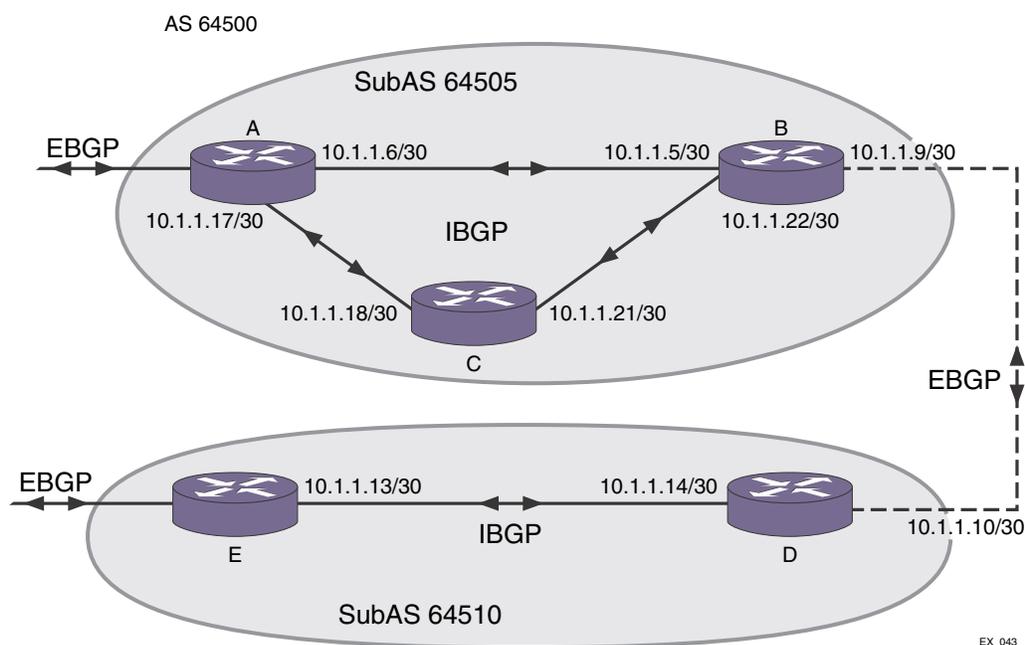
In this example, although the BGP speakers 3.3.3.3 and 4.4.4.4 do not have a direct BGP peering session between them, these speakers still receive routes from each other indirectly through 2.2.2.2. The router 2.2.2.2 is called a route reflector and is responsible for reflecting routes between its clients. Routes received from the client 3.3.3.3 by the router 2.2.2.2 are reflected to 4.4.4.4 and vice-versa. Routes received from 1.1.1.1 are reflected to all clients.

Route Confederations

BGP requires networks to use a fully meshed router configuration. This requirement does not scale well, especially when BGP is used as an IGP. One way to reduce the size of a fully meshed AS is to divide the AS into multiple sub-ASs and to group these sub-ASs into a *routing confederation*. Within the confederation, each sub-AS must be fully meshed. The confederation is advertised to other networks as a single AS.

[Figure 217](#) shows an example of a confederation.

Figure 217: Routing Confederation



EX_043

In this example, AS 64500 has five BGP speakers. Without a confederation, BGP would require that the routes in AS 64500 be fully meshed. Using the confederation, AS 64500 is split into two sub-ASs: AS 64505 and AS 64510. Each sub-AS is fully meshed, and IBGP is running among its members. EBGP is used between sub-AS 64505 and sub-AS 64510. Router B and router D are EBGP peers. EBGP is also used between the confederation and outside ASs.

Inactive Route Advertisement

BGP inactive routes are defined as those routes that are rated *best* by BGP and *not best* in IP routing table. For example, an IGP route to the same destination may be best because it has a higher priority in

the IP route table than the BGP best route. The default configuration of the ExtremeXOS software does not advertise BGP inactive routes to BGP neighbors.

The default configuration (no BGP inactive route advertisement) is more consistent with data traffic forwarding. However, when advertisement of inactive BGP routes is enabled, BGP need not depend upon the route manager module to know whether a BGP route is active or not. This actually improves the performance of BGP processing and advertisement.

When BGP inactive route advertising is enabled, inactive BGP routes are considered for BGP route aggregation. When this feature is disabled, inactive BGP routes are ignored while aggregating routes.

Default Route Origination and Advertisement

The default route origination and advertisement feature allows you to originate and advertise a default route to a BGP neighbor (or to all neighbors in a peer group) even though no default route exists in the local IP routing table. It also allows you to associate policy rules to *conditionally* advertise a default route to BGP neighbors.

When default route origination becomes active, the default route is advertised to the specified BGP neighbors, overriding any previously sent default route. If a default route is added to the local IP routing table while default route origination is active, the default route defined by this feature takes precedence over the new *regular* default route. If default route origination becomes inactive, and a regular default route exists, the regular default route is advertised to BGP neighbors.

When you use a policy with default route origination, the default route is originated only if the local BGP RIB contains a route that matches the policy match conditions. You can use the following match conditions:

- NLRI
- AS-path
- Community
- Origin

You can also use the following policy actions in the policy to set the route attributes:

- AS-path
- Community
- Origin

After a policy is configured for default route origination, BGP must periodically scan the local BGP RIB to make sure that the policy rules evaluate to true for at least one route in local BGP RIB. If the rules evaluate to true, default origination remains active. If the rules evaluate to false, then default origination becomes inactive and the default routes must be withdrawn.

For more information on policy match conditions, actions, and configuration, see [Chapter 19, “Routing Policies.”](#)

Using the Loopback Interface

If you are using BGP as your IGP, you may decide to advertise the interface as available, regardless of the status of any particular interface. The loopback interface can also be used for EBGP multihop. Using the loopback interface eliminates multiple, unnecessary route changes.

Looped AS_Path Attribute

When an EBGP speaker receives a route from its neighbor, it must validate the AS_Path attribute to ensure that there is no loop in the AS_Path. When an EBGP speaker finds its own AS-number in the received EBGP route's AS_Path attribute, it is considered as a *Looped AS Path* and by default, the associated EBGP routes are silently discarded.

There are certain cases (such as in a spoke and hub topology) where it becomes necessary to accept and process EBGP routes with a looped AS_Path attribute. This feature enables you to control the processing of EBGP routes with a looped AS_Path attribute. You can do the following:

- Allow the route with a looped AS_Path to be accepted
- Allow the route with a looped AS_Path to be accepted only if the number of occurrences of its own AS-Number is less than or equal to N , where N is an user-configurable unsigned integer configured
- Silently discard the route with looped AS_Path



NOTE

A looped AS path is always allowed for IBGP, irrespective of the BGP configuration.

BGP Peer Groups

You can use BGP peer groups to group together up to 512 BGP neighbors. All neighbors within the peer group inherit the parameters of the BGP peer group. The following mandatory parameters are shared by all neighbors in a peer group:

- remote AS
- source-interface
- route-policy
- send-community
- next-hop-self

Each BGP peer group is assigned a unique name when it is created, and each peer supports either IPv4 or IPv6 address families (but not both). When the first peer is added to a BGP peer group, the peer group adopts the IPv4 or IPv6 address family of the assigned peer. After the first peer is assigned, the peer group does not support any configuration options or capabilities for the IP address family not selected. For example, if an IPv6 peer is the first peer added to a peer group, the peer group no longer supports IPv4 configuration options or capabilities.

Changes made to the parameters of a peer group are applied to all neighbors in the peer group. Modifying the following parameters will automatically disable and enable the neighbors before changes take effect:

- remote-as
- timer
- source-interface
- soft-in-reset
- password

BGP Route Flap Dampening

Route flap dampening is a BGP feature designed to minimize the propagation of flapping routes across an internetwork. A route is considered to be flapping when it repeatedly alternates between being available and being unavailable. Without route flap dampening, each transition of a route produces a withdrawal or advertisement message, which is propagated throughout the network. Route flapping can generate large numbers of messages, which can impact network bandwidth and availability.

The route flap dampening feature minimizes the flapping problem by halting route advertising and withdrawal messages for the affected route for a period of time. To support route flap dampening, the ExtremeXOS software employs a combination of two techniques. The first technique uses fixed timers to reduce the frequency of route advertisement as specified in RFC 4271. The other technique uses route flap damping algorithms. The software uses a combination of both techniques as specified in RFC 2439.

The fixed timers technique blocks all updates for the flapping route for a period defined by the internal `MinRouteAdvertisementInterval` (MRAI) timer (which is not configurable). For IBGP routes, this timer is set for 5 seconds. For EBGp routes, this timer is set to 30 seconds. The MRAI timer check is independent of the dampening configuration and is used to limit the frequency of route advertisements.

The route flap dampening algorithm uses configurable timers to manage route flap dampening. Suppose that the route to network 172.25.0.0 flaps. The router (in which route dampening is enabled) responds by doing the following:

- Assigns route 172.25.0.0 a penalty of 1000 and moves it to a *history* state in which the penalty value is monitored.
- Increments the penalty value by 1000 for each additional route flap.
- Accumulates penalties and compares them to the suppression limit, which is set to 2000 by default.

If the suppression limit is exceeded when the MRAI timer expires, the route is not advertised to neighbors. A route remains suppressed or dampened until one of the following events occurs:

- The suppression limit is not met when the MRAI timer expires.
- The penalty placed on network 172.25.0.0 is decayed below the reuse limit.
- The maximum suppression timer expires.

The penalty is decayed by reducing the penalty value by one-half at the end of a configurable time period, called the *half-life*. Routes that flap many times may reach a maximum penalty level, or ceiling, after which no additional penalty is added. The ceiling value is not directly configurable, but the configuration parameter used in practice is the maximum route suppression time. No matter how often a route has flapped, after it stops flapping, it is advertised after the maximum route suppression time.

BGP Route Selection

BGP selects routes based on the following precedence (from highest to lowest):

- higher weight
- higher local preference
- shortest length (shortest AS path)
- lowest origin code
- lowest Multi Exit Discriminator (MED)
- route from external peer

- lowest cost to next hop
- lowest routerID

Private AS Number Removal from Route Updates

Private AS numbers are AS numbers in the range 64512 through 65534. You can remove private AS numbers from the AS path attribute in updates that are sent to external BGP (EBGP) neighbors. Possible reasons for using private AS numbers include:

- The remote AS does not have officially allocated AS numbers.
- You want to conserve AS numbers if you are multihomed to the local AS.

Private AS numbers should not be advertised on the Internet. Private AS numbers can be used only locally within an administrative domain. Therefore, when routes are advertised out to the Internet, the routes can be stripped out from the AS paths of the advertised routes using this feature.

Route Redistribution

Multiple protocols, such as BGP, OSPF, and RIP, can be enabled simultaneously on the switch. Route redistribution allows the switch to exchange routes, including static and direct routes, between any two routing protocols.

Exporting routes from another protocol to BGP and from BGP to another protocol are discrete configuration functions. For example, to run OSPFv3 and BGP simultaneously, you must first configure both protocols and then verify the independent operation of each. Then you can configure the routes to export from OSPFv3 to BGP and the routes to export from BGP to OSPFv3.

BGP ECMP

The BGP Equal Cost Multi-path (ECMP) feature supports load sharing by creating a multipath to a destination. This multipath contains multiple routes that are determined to have an equal cost because the following parameters are the same for each route:

- Weight
- Local preference (for IBGP multipaths)
- AS path (entire attribute, not just the length)
- Origin code
- Multi Exit Discriminator (MED)
- IGP distance to the next hop
- Source session (EBGP or IBGP)



NOTE

ECMP does not install an additional path if the next hop is the same as that of the best path. All paths within a multipath must have a unique next hop value.

BGP ECMP does not affect the best path selection. For example, the router continues to designate one of the paths as the best path and advertise this best path to its neighbors. EBGP paths are preferred to IBGP paths.

The BGP ECMP feature allows you to define the maximum number of equal cost paths (up to eight) in a multipath. A multipath for an IBGP destination is called an IBGP multipath, and the multipath for an EBGP destination is called an EBGP multipath.

If there are more equal cost paths for a destination than the configured maximum, the BGP identifier for the advertising BGP speaker is used to establish a path priority. The lower BGP identifier values have priority over the higher values. For example, if the configuration supports 4 paths in a multipath, only the four paths with the lowest BGP identifier values become part of the multipath.

BGP Static Network

ExtremeXOS BGP allows users to add static networks in BGP, which will be redistributed (advertised) into the BGP domain if there is a corresponding active route in the IP routing table. Users can associate a policy with the static BGP network to change or to set the route attributes before the route is advertised to the BGP neighbors.

Graceful BGP Restart

The graceful BGP restart feature enables the switch BGP process to restart without disrupting traffic forwarding. This feature also enables the BGP process to support the graceful BGP restart of a peer router. Without graceful restart, BGP routes within the restarting router are flushed, and BGP routes through the restarting router are flushed from BGP peers. A non-graceful restart interrupts traffic for the time it takes for BGP to restart and re-establish routes, and expends additional resources during the reconvergence.

The following sections provide more information on graceful BGP restart:

- [Graceful Restart in the Restarting Switch on page 1348](#)
- [Graceful Restart on the Receiving Switch on page 1349](#)
- [Planned and Unplanned Restarts on page 1349](#)

Graceful Restart in the Restarting Switch

During session startup, BGP peers indicate whether they have the graceful restart capability. When BGP restarts, the restarting router indicates during the new session startup that it is restarting and provides a restart-time value, which defines how long the receiving router will wait for the restart to complete.

In the restarting router, a graceful BGP restart preserves the BGP routes in the routing table, which allows the router to continue to use those routes until one of the following events occurs:

- The BGP restart is complete.
- The restart update delay timer expires.

During the restart, all pre-existing routes are marked stale. BGP receives new routes during the restart, but the Routing Information Base (RIB) is not updated and advertised until the restart is complete. An End of RIB message is sent when the restart is complete if the graceful restart feature is enabled.

An update-delay timer value determines how long the restarting switch will wait before updating the stale routes. If this timer expires before the restarting switch receives updates from the receiving routers, all stale routes are deleted. If the receiving routers provide updates before this timer expires, the time-stamps for any matching entries in the local RIB are preserved.

After the new BGP session is established, the new session uses the capabilities established with that session, which includes any updates to the graceful restart capability or timers.

Graceful Restart on the Receiving Switch

During session startup, BGP peers indicate whether they have the graceful restart capability. When BGP restarts, the receiving router retains routes received from the restarting router and marks those routes stale. The receiving router continues to advertise the restarting router as if it was fully functional until one of the following events occurs:

- The restarting router sends the EOR marker, indicating the end of a routing update and the end of the graceful restart.
- The restart timer defined by the restarting router expires.
- The stale-route-time timer defined on the receiving router expires.

If the receiving router receives RIB updates and the EOR marker before the timers expire, it updates the local RIB and deletes any stale entries. If either of the timers on the receiving router expires before the receiving switch receives the EOR marker from the restarting switch, all stale routes are deleted.

Planned and Unplanned Restarts

Two types of graceful restarts are defined: planned and unplanned. A planned restart occurs when the software module for BGP is upgraded, or the router operator decides to restart the BGP control function. An unplanned restart occurs when there is some kind of system failure that causes a remote reboot or a crash of BGP, or when an MSM/MM failover occurs. You can decide to configure a router to enter graceful restart for only planned restarts, for only unplanned restarts, or for both. Also, you can decide to configure a router to be a receiver only, and not to do graceful restarts itself.

Cease Subcodes

BGP uses the cease subcode in notification message to convey the reason for terminating the session. The cease subcodes currently supported are given in [Table 135](#).

Table 135: Supported Cease Subcodes

Subcode	Description	Supported?
1	Maximum Number of Prefixes Reached	Yes
2	Administrative Shutdown	Yes
3	Peer De-configured	Yes
4	Administrative Reset	No
5	Connection Rejected	Yes
6	Other Configuration Change	No
7	Connection Collision Resolution	Yes
8	Out of Resources	No

The following sections provide detailed descriptions of each supported cease subcode:

- [Maximum Number of Prefixes Reached on page 1350](#)
- [Administrative Shutdown on page 1350](#)
- [Peer De-configured on page 1350](#)
- [Other Configuration Change on page 1350](#)
- [Connection Collision Resolution on page 1350](#)

Maximum Number of Prefixes Reached

This cease subcode is sent when the number of prefixes from a BGP neighbor exceeds the pre-configured limit. The notification message contains additional data to indicate the maximum prefix limit configured for the neighbor.

Administrative Shutdown

This cease notification subcode is sent to a BGP neighbor in following two situations

- BGP neighbor is disabled
- BGP protocol is globally disabled. All BGP neighbors that were in the established state send cease notifications with this subcode

Peer De-configured

This cease notification subcode is sent when BGP neighbor is deleted.

Other Configuration Change

This cease notification subcode is sent when the following configuration entities change:

- BGP neighbor is added to a peer group
- BGP neighbor is configured as a route-reflector client
- BGP neighbor is part of a peer group and the following configuration elements of the peer group are changed:
 - Password
 - Remote-as
 - Hold-time, keepalive-time
 - Source interface
 - Soft-in-reset

Connection Collision Resolution

This cease notification subcode is sent when there is a BGP connection collision.

Fast External Fallover

BGP fast external fallover uses the BGP protocol to converge quickly in the event of a link failure that connects it to an EBGP neighbor.

When BGP fast external fallover is enabled, the directly-connected EBGP neighbor session is immediately reset when the connecting link goes down.

If BGP fast external fallover is disabled, BGP waits until the default hold timer expires (3 keepalives) to reset the neighboring session. In addition, BGP may tear down the session somewhat earlier than hold timer expiry if BGP detects that the TCP session and its directly connected link is broken (BGP detects this while sending or receiving data from the TCP socket).

Capability Negotiation

BGP supports the negotiation of the following capabilities between BGP peers:

- IPv4 unicast address family
- IPv4 multicast address family
- IPv6 unicast address family
- IPv6 multicast address family
- Route-refresh (code = 64 and Cisco-style code = 128)
- 4-byte-AS (code = 65)

BGP brings up peering with the minimal common capability for the both sides. For example, if a local router with both unicast and multicast capabilities peers with a remote router with unicast capability, the local router establishes the connection with unicast-only capability.

When there are no common capabilities, BGP sends an `Unsupported Capability` error and resets the connection. A manual intervention and configuration change might be required in order to establish a BGP peering session in this particular case.



NOTE

ExtremeXOS version 12.0 and earlier does not negotiate address families. By default, ExtremeXOS version 12.1 advertises MBGP options and is rejected by switches running previous versions, which can delay the establishment of a BGP session. Extreme Networks recommends that you disable the capability advertisement feature of MBGP while peering with switches running previous versions of ExtremeXOS for faster neighbor session establishment.

The following sections provide more information on capability negotiation:

- [IPv4 Capability Negotiation on page 1352](#)
- [IPv6 Capability Negotiation on page 1352](#)

IPv4 Capability Negotiation

For IPv4 peers, BGP supports the following capabilities by default:

- IPv4 unicast address family
- IPv4 multicast address family
- Route-refresh (code = 64 and Cisco-style code = 128)
- 4-byte-AS (code = 65)

By default, BGP sends those capabilities in its OPEN message. In addition, BGP supports graceful restart.

When BGP receives a notification 2/4 (Unsupported optional parameters) in response to an OPEN, it assumes that the peer does not support capability negotiation and MBGP and sends an OPEN message without any capability.

If the peer speaker sends no capabilities, but the local speaker is configured for the IPv4 unicast capability, the assumption is that the peer speaker is operating in legacy mode, and the session defaults to the exchange of IPv4 unicast NLRI (a non MBGP session).

If the local speaker is configured explicitly with the IPv4 unicast family disabled, it cannot peer with legacy peers, and it will send the `Optional Attribute Error` whenever it receives an update packet. Because the IPv4 address family is enabled for Extreme Networks switches by default, it is recommended that you explicitly disable this address family when you desire non-standard behavior.

IPv6 Capability Negotiation

For IPv6 peers, the route refresh capability is enabled by default, and no address family is enabled by default. You must enable a common set of capabilities on the local and neighbor peers before peering can be established. For IPv6 capability negotiation, IPv6 peering is set to *idle* if no common address families are negotiated. IPv6 BGP peering supports only the IPv6 unicast and IPv6 multicast address families; IPv4 address families are not supported.

Route Refresh

Route Refresh helps minimize the memory footprint of BGP by not storing the original BGP route path attributes from a neighbor that advertises route refresh capability in an OPEN message. Whenever you execute the command `configure bgp neighbor [<remoteAddr> | all] {address-family [ipv4-unicast | ipv4-multicast]} soft-reset in`, BGP sends a route refresh message to its peer if that peer had advertised route refresh capability in its OPEN message. In response to the route refresh message, the neighbor sends its entire RIB-OUT database for the requested address family. This helps reapply the inbound neighbor policy, if there are any changes.

Configuring BGP

The following sections describe how to configure BGP:

- [Configuration Overview on page 1353](#)
- [Configuring BGP Router Settings on page 1354](#)
- [Configuring BGP Neighbors on page 1356](#)
- [Configuring BGP Peer Groups on page 1361](#)
- [Creating and Deleting BGP Static Networks on page 1362](#)
- [Importing Routes from Other Protocols to BGP on page 1362](#)
- [Exporting BGP Routes to other Protocols on page 1362](#)
- [Configuring Route Aggregation on page 1363](#)
- [Configuring Route Reflectors on page 1363](#)
- [Configuring a Route Confederation on page 1364](#)

Configuration Overview

The following procedure configures a basic BGP topology:

- 1 Configure the interfaces that will connect to BGP neighbors. For each interface, do the following:
 - a Create a VLAN.
 - b Assign one or more ports to the VLAN.
 - c Configure a VLAN IP address.
 - d Enable IP forwarding on the VLAN.

For more information on configuring VLANs, see [Chapter 12, “VLANs.”](#)

- 2 Configure the BGP router ID using the following command:
- 3 Configure the AS number to which the router should belong using the following command:
- 4 To add one or more IBGP neighbors, use the following command and specify the AS number to which the router belongs:
- 5 To add one or more EBGP neighbors, use the following command and specify the AS number of the remote AS (which is different from the AS to which the router belongs):
- 6 If you want to simultaneously configure BGP options for multiple neighbors, create and configure peer groups as described in [“Configuring BGP Peer Groups” on page 1361](#).
- 7 If the BGP network will support IPv4 traffic, you can skip this step. If the BGP network will support any other address family, you must enable support for that address family on BGP neighbors with either of the following commands:

```
enable bgp neighbor [all | <remoteaddr>] capability [ipv4-unicast | ipv4-multicast |
ipv6-unicast | ipv6-multicast | route-refresh]
```

```
enable bgp peer-group <peer-group-name> capability [ipv4-unicast | ipv4-multicast |
ipv6-unicast | ipv6-multicast | route-refresh]
```

- 8 To configure additional BGP neighbor options, see “Configuring BGP Neighbors” on page 1356.
- 9 For instructions on configuring additional BGP features, see the list under “Configuring BGP” on page 1353.
- 10 Enable BGP neighbors using the following command:

```
enable bgp neighbor [<remoteaddr> | all]
```
- 11 Enable BGP using the following command:

```
enable bgp
```

For instructions on displaying BGP information, see “Displaying BGP Information” on page 1365.

Configuring BGP Router Settings

The following sections describe how to configure BGP settings that apply to the entire router:

- [Configuring the BGP Router ID on page 1354](#)
- [Configuring the AS Number on page 1354](#)
- [Configuring the AS Number and Community Display Formats on page 1354](#)
- [Configuring the BGP Local Preference on page 1354](#)
- [Configuring the BGP MED on page 1355](#)
- [Configuring BGP ECMP on page 1355](#)
- [Configuring Graceful BGP Restart on page 1355](#)
- [Configuring Fast External Fallover on page 1355](#)

Configuring the BGP Router ID

To configure the BGP router ID, use the following command:

```
configure bgp routerid <router identifier>
```

Configuring the AS Number

To configure the AS number for the switch, use the following command:

```
configure bgp AS-number <number>
```

Configuring the AS Number and Community Display Formats

To configure the AS number display format, use the following commands:

```
configure bgp as-display-format [asdot | asplain]
```

```
enable bgp community format AS-number : number
```

```
disable bgp community format AS-number : number
```

Configuring the BGP Local Preference

To configure the BGP local preference, use the following command:

```
configure bgp local-preference <number>
```

Configuring the BGP MED

To configure the BGP MED, use the following commands:

```
configure bgp med [none | <bgp_med>]
```

```
enable bgp always-compare-med
```

```
disable bgp always-compare-med
```

Configuring BGP ECMP

To enable or disable BGP ECMP, enter the following command:

```
configure bgp maximum-paths <max-paths>
```

The `max-paths` setting applies to BGP on the current VR. Specify more than 1 path to enable BGP ECMP and define the maximum number of paths for IBGP and EBGp multipaths. Specify 1 path to disable ECMP. To display BGP ECMP configuration information, use the `show bgp` command.

Configuring Graceful BGP Restart

To configure a router to perform graceful BGP restart, use the following command:

```
configure bgp restart [none | planned | unplanned | both | aware-only]
```

The address families participating in graceful restart are configured using the following command:

```
configure bgp restart [add | delete] address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]
```

There are three timers that can be configured with the following commands:

```
configure bgp restart restart-time <seconds>
```

```
configure bgp restart stale-route-time <seconds>
```

```
configure bgp restart update-delay <seconds>
```

You can use the following commands to verify the BGP graceful restart configuration:

```
show bgp
```

```
show bgp neighbor <remoteaddr> {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} [accepted-routes | received-routes | rejected-routes | transmitted-routes] {detail} [all | as-path <path-expression> | community [no-advertise | no-export | no-export-subconfed | number <community-number> | <autonomous-system-id> : <bgp-community>] | network [any / <netMaskLen> | <networkPrefixFilter>] {exact}]
```

Configuring Fast External Fallover

The fast external fallover module consists of two commands; one for enabling fallover (`enable bgp fast-external-fallover`) and one for disabling fallover (`disable bgp fast-external-fallover`). Fast external fallover is disabled by default.

These commands apply to all directly-connected external BGP neighbors.

Configuring BGP Neighbors

The following sections describe how to configure BGP neighbors:

- [Creating and Deleting BGP Neighbors on page 1356](#)
- [Configuring a Description for a Neighbor on page 1356](#)
- [Configuring a Password for Neighbor Communications on page 1356](#)
- [Configuring the Supported Address Families and Route Refresh on page 1356](#)
- [Configuring Timers for BGP Neighbor Communications on page 1357](#)
- [Configuring the Neighbor Shutdown Priority on page 1357](#)
- [Configuring Route Acceptance on page 1357](#)
- [Configuring Route Origination on page 1358](#)
- [Configuring a Route Map Filter on page 1360](#)
- [Enabling and Disabling the Soft Input Reset Feature for a Neighbor on page 1360](#)
- [Configuring Route Flap Dampening on page 1360](#)

Creating and Deleting BGP Neighbors

To create or delete BGP neighbors, use the following commands:

```
create bgp neighbor <remoteaddr> remote-AS-number <as-number> {multi-hop}
```

```
create bgp neighbor <remoteaddr> peer-group <peer-group-name> {multi-hop}
```

```
delete bgp neighbor [<remoteaddr> | all]
```

Configuring a Description for a Neighbor

To configure a description for one or all BGP neighbors, use the following command:

```
configure bgp neighbor [all | <remoteaddr>] description {<description>}
```

Configuring a Password for Neighbor Communications

To configure a password to use for communications with BGP neighbors, use the following command:

```
configure bgp neighbor [all | <remoteaddr>] password [none | {encrypted}
<tcpPassword>]
```

To configure a password for the neighbors in a peer group, use the following command:

```
configure bgp peer-group <peer-group-name> password [none | <tcpPassword>]
```

Configuring the Supported Address Families and Route Refresh

All BGP negotiated capabilities (except for the 4-Byte-AS capability) can be enabled and disabled using the following commands:

```
enable bgp neighbor [all | <remoteaddr>] capability [ipv4-unicast | ipv4-multicast |
ipv6-unicast | ipv6-multicast | route-refresh]
```

```
disable bgp neighbor [all | <remoteaddr>] capability [ipv4-unicast | ipv4-multicast |
ipv6-unicast | ipv6-multicast | route-refresh]
```

To configure the capabilities for a peer group, use the following commands:

```
enable bgp peer-group <peer-group-name> capability [ipv4-unicast | ipv4-multicast |
ipv6-unicast | ipv6-multicast | route-refresh]
```

```
disable bgp peer-group <peer-group-name> capability [ipv4-unicast | ipv4-multicast |
ipv6-unicast | ipv6-multicast | route-refresh]
```

Configuring Timers for BGP Neighbor Communications

To configure the timers that apply to communications with a neighbor, use the following command:

```
configure bgp neighbor [<remoteaddr> | all] timer keep-alive <keepalive> hold-time
<holdtime>
```

To configure the timers that apply to the neighbors in a peer group, use the following command:

```
configure bgp peer-group <peer-group-name> timer keep-alive <seconds> hold-time
<seconds>
```

Configuring the Neighbor Shutdown Priority

To configure the neighbor shutdown priority, use the following command:

```
configure bgp neighbor [all | <remoteaddr>] shutdown-priority <number>
```

Configuring Route Acceptance

The following sections describe configuration options that control which routes are accepted from neighbors:

- [Assigning a Weight Value to Routes Learned from a Neighbor on page 1357](#)
- [Configuring the Maximum Number of Prefixes on page 1357](#)
- [Configuring Acceptance of Looped BGP Routes from Neighbors on page 1358](#)

Assigning a Weight Value to Routes Learned from a Neighbor. To configure the weight value that applies to routes learned from a neighbor, use the following command:

```
configure bgp neighbor [<remoteaddr> | all] weight <weight>
```

To configure the weight value that applies to routes learned from the neighbors in a peer group, use the following command:

```
configure bgp peer-group <peer-group-name> weight <number>
```

Configuring the Maximum Number of Prefixes. To configure the maximum number of prefixes to accept from a BGP neighbor, use the following command:

```
configure bgp neighbor [<remoteaddr> | all] {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} maximum-prefix <number> {{threshold
<percent>}} {teardown {holddown-interval <seconds>}} {send-traps}
```

To configure the maximum number of prefixes to accept from the neighbors in a peer group, use the following command:

```
configure bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} maximum-prefix <number> {{threshold
<percent>}} {teardown {holddown-interval <seconds>}} {send-traps}
```

Configuring Acceptance of Looped BGP Routes from Neighbors. To enable and disable the acceptance of looped routes from one or all neighbors, use the following commands:

```
configure bgp neighbor [all | <remoteaddr>] {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} allows-in {max-as-occurrence <as-count>}
```

```
configure bgp neighbor [all | <remoteaddr>] {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} dont-allowas-in
```

To enable and disable the acceptance of looped routes from the neighbors in a peer group, use the following commands:

```
configure bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} allows-in {max-as-occurrence <as-count>}
```

```
configure bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} dont-allowas-in
```

Configuring Route Origination

The following sections describe configuration options that control how routes are originated and sent to neighbors:

- [Configuring the Source Interface Address on page 1358](#)
- [Enabling and Disabling Default Route Origination on page 1358](#)
- [Configuring Inactive Route Advertisement on page 1359](#)
- [Configuring the Originating Next Hop Address for Outgoing Updates on page 1359](#)
- [Including or Excluding the Community Path Attribute on page 1359](#)
- [Removing Private AS Numbers from Route Updates on page 1359](#)

Configuring the Source Interface Address. To configure the source interface address to use for communications with a neighbor, use the following command:

```
configure bgp neighbor [<remoteaddr> | all] source-interface [any | ipaddress
<ipAddr>]
```

To configure the source interface address to use for communications with neighbors in a peer group, use the following command:

```
configure bgp peer-group <peer-group-name> source-interface [any | ipaddress <ipAddr>]
```

Enabling and Disabling Default Route Origination. To enable or disable BGP default route origination and advertisement for BGP neighbors, use the following commands:

```
enable bgp [{neighbor} <remoteaddr> | neighbor all] {address-family [ipv4-unicast |
ipv4-multicast | ipv6-unicast | ipv6-multicast]} originate-default {policy <policy-
name>}
```

```
disable bgp [{neighbor} <remoteaddr> | neighbor all] {address-family [ipv4-unicast |
ipv4-multicast | ipv6-unicast | ipv6-multicast]} originate-default
```

To enable or disable BGP default route origination and advertisement for a peer group, use the following commands:

```
enable bgp {peer-group} <peer-group-name> {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} originate-default {policy <policy-name>}
```

```
disable bgp {peer-group} <peer-group-name> {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} originate-default
```

Configuring Inactive Route Advertisement. This command applies to the specified address family for all neighbors. To enable or disable BGP inactive route advertising, use the following commands:

```
enable bgp {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} advertise-inactive-route
```

```
disable bgp {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} advertise-inactive-route
```

Configuring the Originating Next Hop Address for Outgoing Updates. To configure outgoing updates to the specified neighbors to specify the address of the BGP connection originating the update as the next hop address, use the following command:

```
configure bgp neighbor [<remoteaddr> | all] {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} [next-hop-self | no-next-hop-self]
```

To make a configuration change for the neighbors in a peer group, use the following command:

```
configure bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} [next-hop-self | no-next-hop-self]
```

Including or Excluding the Community Path Attribute. To configure neighbor communications to include or exclude the community path attribute, use the following command:

```
configure bgp neighbor [<remoteaddr> | all] {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} [send-community | dont-send-community] {both | extended | standard}
```

To make a configuration change for the neighbors in a peer group, use the following command:

```
configure bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} [send-community | dont-send-community] {both | extended | standard}
```

Removing Private AS Numbers from Route Updates. To configure private AS numbers to be removed from updates for neighbors or peer groups, use the following commands:

```
enable bgp neighbor [<remoteaddr> | all] remove-private-AS-numbers
```

```
enable bgp peer-group <peer-group-name> remove-private-AS-numbers
```

To disable this feature, use the following commands:

```
disable bgp neighbor [<remoteaddr> | all] remove-private-AS-numbers
```

```
disable bgp peer-group <peer-group-name> remove-private-AS-numbers
```

Configuring a Route Map Filter

To configure a route map filter for one or all BGP neighbors, use the following command:

```
configure bgp neighbor [<remoteaddr> | all] {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} route-policy [in | out] [none | <policy>]
```

To configure a route map filter for the neighbors in a peer group, use the following command:

```
configure bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} route-policy [in |out] [none | <policy>]
```

Enabling and Disabling the Soft Input Reset Feature for a Neighbor

To enable or disable the soft input reset feature for a neighbor, use the following commands:

```
enable bgp neighbor [all | <remoteaddr>] {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} soft-in-reset
```

```
disable bgp neighbor [all | <remoteaddr>] {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} soft-in-reset
```

To enable or disable the soft input reset feature for a peer group, use the following commands:

```
enable bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-multicast
| ipv6-unicast | ipv6-multicast]} soft-in-reset
```

```
disable bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} soft-in-reset
```

Configuring Route Flap Dampening

You can supply the dampening configuration parameters directly through a command line interface (CLI) command, or use the command to associate a policy that contains the desired parameters.

To enable route flap dampening for neighbors or a peer group, use the following commands:

```
configure bgp neighbor [all | <remoteaddr>] {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} dampening {{half-life <half-life-minutes>
{reuse-limit <reuse-limit-number> suppress-limit <suppress-limit-number> max-suppress
<max-suppress-minutes>} | policy-filter [<policy-name> | none]}}
```

```
configure bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} dampening {{half-life <half-life-minutes>
{reuse-limit <reuse-limit-number> supress-limit <suppress-limit-number> max-suppress
<max-suppress-minutes>}} | policy-filter [<policy-name> | none]}}
```

To disable route flap dampening for a BGP neighbor or peer group, use the following commands:

```
configure bgp neighbor [<remoteaddr> | all] {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} no-dampening
```

```
configure bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} no-dampening
```



NOTE

When you disable dampening, all the configured dampening parameters are deleted.

Configuring BGP Peer Groups

The following sections describe how to configure BGP neighbors:

- [Creating or Deleting a BGP Peer Group on page 1361](#)
- [Adding Neighbors to a BGP Peer Group on page 1361](#)
- [Configuring a Remote AS Number for a Peer Group on page 1361](#)

Creating or Deleting a BGP Peer Group

To create or delete peer groups, use the following commands:

```
create bgp peer-group <peer-group-name>
delete bgp peer-group <peer-group-name>
```



NOTE

No capabilities are enabled at time of peer-group creation. If an IPv4 peer is the first peer added to the peer-group, the IPv4-unicast and IPv4-multicast capabilities are enabled by default. If the first peer assigned to a peer-group is an IPv6 peer, no capabilities are enabled.

Adding Neighbors to a BGP Peer Group

To create a new neighbor and add it to a BGP peer group, use the following command:

```
create bgp neighbor <remoteaddr> peer-group <peer-group-name> {multi-hop}
```

The new neighbor is created as part of the peer group and inherits all of the existing parameters of the peer group. The peer group must have remote AS configured.

To add an existing neighbor to a peer group, use the following command:

```
configure bgp neighbor [all | <remoteaddr>] peer-group [<peer-group-name> | none]
{acquire-all}
```

If you do not specify the `acquire-all` option, only the mandatory parameters are inherited from the peer group. If you specify the `acquire-all` option, all of the parameters of the peer group are inherited. This command disables the neighbor before adding it to the peer group.

To remove a neighbor from a peer group, use the `peer-group none` option.

When you remove a neighbor from a peer group, the neighbor retains the parameter settings of the group. The parameter values are *not* reset to those the neighbor had before it inherited the peer group values.

Configuring a Remote AS Number for a Peer Group

To configure a remote AS number for a peer group, use the following command:

```
configure bgp peer-group <peer-group-name> remote-AS-number <number>
```

Creating and Deleting BGP Static Networks

To create a static BGP network, use the following command:

```
configure bgp add network {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} <ipaddress/masklength> {network-policy <policy>}
```



NOTE

This command adds the route to BGP only if the route is present in the routing table.

To delete a static BGP network, use the following command:

```
configure bgp delete network {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} [all | <ipaddress/mask length>]
```

Importing Routes from Other Protocols to BGP

Before importing routes from another protocol to BGP, you must first configure both protocols and then verify the independent operation of each. When you import routes from another protocol, the imported routes are limited to those for the respective address family and protocol. For example, you can import IPv4 unicast routes from RIP to BGP, but you cannot import IPv6 unicast routes from RIP to BGP. IPv6 routes can be imported only from IPv6 routing protocols; and IPv4 routes can be imported only from IPv4 routing protocols.

You can use route maps to associate BGP attributes including Community, NextHop, MED, Origin, and Local Preference with the routes. Route maps can also be used to filter out exported routes.

For instructions on importing routes from another protocol to BGP, refer to the chapter for the protocol from which you want to import routes.

To configure an import policy to apply to imported routes, use the following commands:

```
configure bgp import-policy [<policy-name> | none]
```

Exporting BGP Routes to other Protocols

Before exporting routes from BGP to another protocol, you must first configure both protocols and then verify the independent operation of each. When you export routes from BGP, the exported routes are limited to those for the respective address family and protocol. For example, you can export IPv4 unicast routes from BGP to RIP, but you cannot export IPv6 unicast routes from BGP to RIP. IPv6 routes can be exported only from BGP to IPv6 routing protocols; and IPv4 routes can be exported only to IPv4 routing protocols.

You can use route maps to associate BGP attributes including Community, NextHop, MED, Origin, and Local Preference with the routes. Route maps can also be used to filter out exported routes.

To enable or disable the export of BGP routes to another protocol, use the following commands:

```
enable bgp export [blackhole | direct | isis | isis-level-1 | isis-level-1-external | isis-level-2 | isis-level-2-external | ospf | ospf-extern1 | ospf-extern2 | ospf-inter | ospf-intra | ospfv3 | ospfv3-extern1 | ospfv3-extern2 | ospfv3-inter | ospfv3-intra | rip | ripng | static {address-family [{ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast}]} {export-policy <policy-name>}
```

```
disable bgp export [blackhole | direct | isis | isis-level-1 | isis-level-1-external |
isis-level-2 | isis-level-2-external | ospf | ospf-extern1 | ospf-extern2 | ospf-inter
| ospf-intra | ospfv3 | ospfv3-extern1 | ospfv3-extern2 | ospfv3-inter | ospfv3-intra
| rip | ripng | static {address-family [{ipv4-unicast | ipv4-multicast | ipv6-unicast |
ipv6-multicast}]}
```

**NOTE**

When exporting BGP routes, static routes, configured with the `configure bgp add network` command, take precedence over BGP discovered routes.

Configuring Route Aggregation

Route aggregation is the process of combining the characteristics of several routes so that they are advertised as a single route. Aggregation reduces the amount of information that a BGP speaker must store and exchange with other BGP speakers. Reducing the information that is stored and exchanged also reduces the size of the routing table.

To enable or disable BGP route aggregation, use the following commands:

```
enable bgp aggregation
```

```
disable bgp aggregation
```

To create or remove aggregate routes, use the following commands:

```
configure bgp add aggregate-address {address-family [ipv4-unicast | ipv4-multicast |
ipv6-unicast | ipv6-multicast]} <ipaddress/masklength> {as-match | as-set}
{summary-only} {advertise-policy <policy>} {attribute-policy <policy>}
```

```
configure bgp delete aggregate-address {address-family [ipv4-unicast | ipv4-multicast
| ipv6-unicast | ipv6-multicast]} [<ip address/masklength> | all]
```

Configuring Route Reflectors

The configuration for a router reflector topology takes place on the router or routers that serve as route reflectors. Route reflector clients must be configured for BGP participation, but no special configuration is required on route reflector clients to support the route reflector.

To configure a route reflector to treat neighbors or peer group neighbors as route reflector clients, use the following commands:

```
configure bgp neighbor [<remoteaddr> | all] [route-reflector-client | no-route-
reflector-client]
```

```
configure bgp peer-group <peer-group-name> [route-reflector-client | no-route-
reflector-client]
```

If multiple route reflectors are used in a cluster, you must configure the route reflector clients on each route reflector, and you must configure each route reflector with a common cluster ID using the following command:

```
configure bgp cluster-id <cluster-id>
```

Configuring a Route Confederation

Configure every router in the confederation with the same confederation ID using the following command:

```
configure bgp confederation-id <number>
```

For each EBGP confederation peer, use the following command to configure the remote AS number as a confederation sub-AS-number:

```
configure bgp add confederation-peer sub-AS-number <number>
```

To remove the sub-AS-number configuration for an EBGP peer, use the following command:

```
configure bgp delete confederation-peer sub-AS-number <number>
```

Managing BGP

The following sections describe common BGP management tasks:

- [Enabling and Disabling BGP Neighbors on page 1364](#)
- [Enabling and Disabling a Peer Group on page 1364](#)
- [Enabling and Disabling BGP on page 1364](#)
- [Displaying BGP Information on page 1365](#)
- [Reapplying a Policy on page 1365](#)
- [Clearing BGP Flap, Session, or Route Statistics on page 1365](#)
- [Clearing BGP Neighbor Counters on page 1365](#)

Enabling and Disabling BGP Neighbors

To enable or disable a BGP neighbor, use the following commands:

```
enable bgp neighbor [<remoteaddr> | all]
```

```
disable bgp neighbor [<remoteaddr> | all]
```

Enabling and Disabling a Peer Group

To enable or disable a peer group, use the following commands:

```
enable bgp peer-group <peer-group-name>
```

```
disable bgp peer-group <peer-group-name>
```

Enabling and Disabling BGP

To enable or disable BGP on the switch, use the following commands:

```
enable bgp
```

```
disable bgp
```

Refreshing BGP Routes

To refresh the routes for a BGP neighbor, use the following command:

```
configure bgp neighbor [<remoteaddr> | all] {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} soft-reset {in | out}
```

```
configure bgp peer-group <peer-group-name> {address-family [ipv4-unicast | ipv4-
multicast | ipv6-unicast | ipv6-multicast]} soft-reset {in | out}
```

Reapplying a Policy

To reapply the route policy associated with the network command, aggregation, import, and redistribution, use the following command:

```
configure bgp soft-reconfiguration
```

Clearing BGP Flap, Session, or Route Statistics

To clear the BGP flap statistics, use the following command:

```
clear bgp {neighbor} <remoteaddr> {address-family [ipv4-unicast | ipv4-multicast |
ipv6-unicast | ipv6-multicast]} flap-statistics [all | as-path <path expression> |
community [no-advertise | no-export | no-export-subconfed | number <community_num> |
<AS_Num>:<Num>] | network [any / <netMaskLen> | <networkPrefixFilter>] {exact}}
```

Clearing BGP Neighbor Counters

To clear the counters for a BGP neighbor, use the following command:

```
clear bgp neighbor [<remoteaddr> | all] counters
```

Displaying BGP Information

The following sections describe how to display different types of BGP information:

- [Displaying BGP Router Configuration and Route Statistics on page 1365](#)
- [Displaying Peer Group Configuration Information on page 1366](#)
- [Displaying BGP Route Information on page 1366](#)
- [Displaying BGP Memory Usage on page 1366](#)

Displaying BGP Router Configuration and Route Statistics

To display BGP router configuration and route statistics, enter the following command:

```
show bgp
```

Displaying Peer Group Configuration Information

To display peer group configuration information, enter the following command:

```
show bgp peer-group {detail | <peer-group-name> {detail}}
```

Displaying BGP Route Information

To display summary route information, enter the following command:

```
show bgp routes {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} summary
```

To display route information and statistics, enter the following command:

```
show bgp routes {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} {detail} [all | as-path <path-expression> | community [no-advertise | no-export | no-export-subconfed | number <community-number> | <autonomous-system-id> : <bgp-community>] | network [any / <netMaskLen> | <networkPrefixFilter>] {exact}]
```

To display information about routes exchanged with a neighbor, enter the following command:

```
show bgp neighbor <remoteaddr> {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} [accepted-routes | received-routes | rejected-routes | transmitted-routes] {detail} [all | as-path <path-expression> | community [no-advertise | no-export | no-export-subconfed | number <community-number> | <autonomous-system-id> : <bgp-community>] | network [any / <netMaskLen> | <networkPrefixFilter>] {exact}]
```

To display information about suppressed or dampened routes, enter the following command:

```
show bgp neighbor <remoteaddr> {address-family [ipv4-unicast | ipv4-multicast | ipv6-unicast | ipv6-multicast]} [accepted-routes | received-routes | rejected-routes | transmitted-routes] {detail} [all | as-path <path-expression> | community [no-advertise | no-export | no-export-subconfed | number <community-number> | <autonomous-system-id> : <bgp-community>] | network [any / <netMaskLen> | <networkPrefixFilter>] {exact}]
```

Displaying BGP Memory Usage

To display BGP memory usage information, enter the following command:

```
show bgp memory {detail | <memoryType>}
```

Configuration Examples

This section provide the following configuration examples:

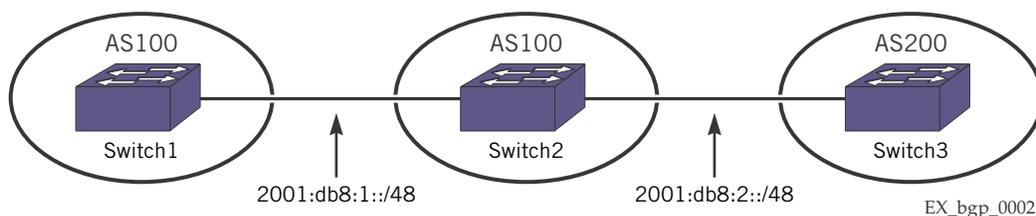
- [BGP IPv6 Example on page 1367](#)
- [Graceful BGP Restart Configuration Example for IPv4 on page 1371](#)
- [Graceful BGP Restart Configuration Example for IPv6 on page 1372](#)
- [Route Reflector Example for IPv4 on page 1372](#)
- [Route Reflector Example for IPv6 on page 1374](#)
- [Route Confederation Example for IPv4 on page 1377](#)

- [Route Confederation Example for IPv6 on page 1379](#)
- [Default Route Origination Example for IPv4 on page 1381](#)
- [Default Route Origination Example for IPv6 on page 1382](#)
- [BGP Speaker Black Hole Example on page 1382](#)
- [BGP Route Filtering Example for IPv4 on page 1386](#)
- [BGP Route Filtering Example for IPv6 on page 1391](#)
- [Route Aggregation Example for IPV4 on page 1396](#)
- [Route Aggregation Example for IPv6 on page 1398](#)

BGP IPv6 Example

Figure 218 shows the network topology for this example.

Figure 218: BGP IPv6 Example



The following sections provide information on this example:

- [Switch1 Configuration on page 1367](#)
- [Switch2 Configuration on page 1368](#)
- [Switch3 Configuration on page 1368](#)
- [Configuration Displays \(show Commands\) for Switch2 on page 1368](#)

Switch1 Configuration

```

create vlan v1
configure v1 ipaddress 2001:db8:1::1/48
configure v1 add ports 1
create vlan net
configure net add ports 3
configure net ipaddress 2001:db8:22::1/48
enable ipforwarding ipv6
configure bgp AS-number 100
configure bgp routerid 1.1.1.1
create bgp neighbor 2001:db8:2131::2 remote-AS-number 100
enable bgp neighbor all capability ipv6-unicast
enable bgp neighbor all
enable bgp
configure bgp add network address-family ipv6-unicast 2001:db8:22::/48
configure iproute add 2001:db8:2131::/48 2001:db8:1::2
configure ospfv3 routerid 1.1.1.1
configure ospfv3 add vlan v1 area 0.0.0.0
enable ospfv3

```

Switch2 Configuration

```

create vlan v1
create vlan v2
create vlan lpback
enable loopback lpback
configure v1 ipaddress 2001:db8:1::2/48
configure v2 ipaddress 2001:db8:2::1/48
configure lpback ipaddress 2001:db8:2131::2/48
enable ipforwarding ipv6
configure v1 add ports 1:9
configure v2 add ports 1:11
configure bgp AS-number 100
configure bgp routerid 1.1.1.2
create bgp neighbor 2001:db8:1::1 remote-AS-number 100
create bgp neighbor 2001:db8:2::2 remote-AS-number 200
configure bgp neighbor 2001:db8:1::1 source-interface ipaddress 2001:db8:2131::2
enable bgp neighbor all capability ipv6-unicast
enable bgp adj-rib-out
enable bgp neighbor all
enable bgp
configure ospfv3 routerid 1.1.1.2
configure ospfv3 add vlan all area 0.0.0.0
enable ospfv3

```

Switch3 Configuration

```

create vlan v1
create vlan net
configure v1 add ports 2:11
configure net add ports 1:23
configure v1 ipaddress 2001:db8:2::2/48
configure net ipaddress 2001:db8:55::1/48
enable ipforwarding ipv6
configure bgp AS-number 200
configure bgp routerid 2.1.1.2
create bgp neighbor 2001:db8:2::1 remote-AS-number 100
enable bgp neighbor all capability ipv6-unicast
enable bgp neighbor all
enable bgp
enable bgp export static address-family ipv6-unicast
enable bgp export direct address-family ipv6-unicast
configure iproute add 2001:db8:66::/48 2001:db8:55::100

```

Configuration Displays (show Commands) for Switch2

```
* Switch2.47 # show bgp neighbor
```

Peer	AS	Weight	State	InMsgs	OutMsgs(InQ)	Up/Down
Ie-- 2001:db8:1::1	100	1	ESTABLISHED	17	19 (0)	0:0:11:08
Ee-- 2001:db8:2::2	200	1	ESTABLISHED	28	24 (0)	0:0:01:53

```

Flags: (d) disabled, (e) enabled, (E) external peer, (I) internal peer
       (m) EBGP multihop, (r) route reflector client

```

BGP Peer Statistics

```

Total Peers      : 2
EBGP Peers      : 1
RR Client       : 0
Enabled         : 2
IBGP Peers      : 1
EBGP Multihop   : 0
Disabled        : 0

```

* Switch2.50 # show bgp routes address-family ipv6-unicast all

Routes:

	Destination	LPref	Weight	MED
	Peer	Next-Hop		
	AS-Path			
* ?	2001:db8:2::/48	100	1	0
	2001:db8:2::2	2001:db8:2::2		
	200			
*>?	2001:db8:55::/48	100	1	0
	2001:db8:2::2	2001:db8:2::2		
	200			
*>?	2001:db8:66::/48	100	1	0
	2001:db8:2::2	2001:db8:2::2		
	200			
*>i	2001:db8:22::/48	100	1	0
	2001:db8:1::1	2001:db8:1::1		

Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
(s) Stale, (m) Multipath, (u) Unfeasible

Origin: (?) Incomplete, (e) EGP, (i) IGP

BGP Route Statistics

```

Total Rxed Routes : 4
Feasible Routes   : 4
Active Routes     : 3
Rejected Routes   : 0
Unfeasible Routes : 0

```

Route Statistics on Session Type

```

Routes from Int Peer: 1
Routes from Ext Peer: 3

```

Switch2.57 # show bgp neighbor 2001:db8:1::1 address-family ipv6-unicast received-routes all

Routes:

	Destination	LPref	Weight	MED
	Peer	Next-Hop		
	AS-Path			
*>i	2001:db8:22::/48	100	1	0
	2001:db8:1::1	2001:db8:1::1		

Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
(s) Stale, (m) Multipath, (u) Unfeasible

Origin: (?) Incomplete, (e) EGP, (i) IGP

BGP Route Statistics

Total Rxed Routes : 1
Feasible Routes : 1
Active Routes : 1
Rejected Routes : 0
Unfeasible Routes : 0

Switch2.59 # show bgp routes address-family ipv6-unicast detail all

Routes:

Route: 2001:db8:2::/48, Peer 2001:db8:2::2, BEST
Origin Incomplete, Next-Hop 2001:db8:2::2, LPref 100, MED 0
Weight 1,
As-PATH: 200

Route: 2001:db8:55::/48, Peer 2001:db8:2::2, BEST, Active
Origin Incomplete, Next-Hop 2001:db8:2::2, LPref 100, MED 0
Weight 1,
As-PATH: 200

Route: 2001:db8:66::/48, Peer 2001:db8:2::2, BEST, Active
Origin Incomplete, Next-Hop 2001:db8:2::2, LPref 100, MED 0
Weight 1,
As-PATH: 200

Route: 2001:db8:22::/48, Peer 2001:db8:1::1, BEST, Active
Origin IGP, Next-Hop 2001:db8:1::1, LPref 100, MED 0
Weight 1,
As-PATH:

BGP Route Statistics

Total Rxed Routes : 4
Feasible Routes : 4
Active Routes : 3
Rejected Routes : 0
Unfeasible Routes : 0

Route Statistics on Session Type

Routes from Int Peer: 1
Routes from Ext Peer: 3

```
Switch2.72 # sh bgp neighbor 2001:db8:2::2 address-family ipv6-unicast transmitted-
routes all
```

Advertised Routes:

Destination	LPref	Weight	MED
Peer	Next-Hop		
AS-Path			

>i 2001:db8:22::/48	0		0
100	2001:db8:2::1		

Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
(s) Stale, (m) Multipath, (u) Unfeasible

Origin: (?) Incomplete, (e) EGP, (i) IGP

BGP Route Statistics

Advertised Routes : 1

Graceful BGP Restart Configuration Example for IPv4

In the following IPv4 configuration example, EXOS-1 is the restarting BGP router, and EXOS-2 is the receiving BGP router.

To configure router EXOS-1, use the following commands:

```
create vlan bgp-restart
configure vlan bgp-restart add port 2:2
configure vlan bgp-restart ipaddress 10.0.0.1/24
enable ipforwarding

configure bgp as-number 100
configure bgp route-id 10.0.0.1
configure bgp restart both
create bgp neighbor 10.0.0.2 remote-as 64500
enable bgp neighbor all
enable bgp
```

To configure router EXOS-2, use the following commands:

```
create vlan bgp-restart
configure vlan bgp-restart add port 2:5
configure vlan bgp-restart ipaddress 10.0.0.2/24
enable ipforwarding

configure bgp as-number 64500
configure bgp route-id 10.0.0.2
configure bgp restart aware-only
create bgp neighbor 10.0.0.1 remote-as 100
enable bgp neighbor all
enable bgp
```

Graceful BGP Restart Configuration Example for IPv6

In the following IPv6 configuration example, EXOS-1 is the restarting BGP router, and EXOS-2 is the receiving BGP router.

To configure router EXOS-1, use the following commands:

```
create vlan bgp-restart
configure vlan bgp-restart add port 2:2
configure vlan bgp-restart ipaddress 2001:db8:1::1/48
enable ipforwarding ipv6
configure bgp as-number 100
configure bgp routerid 10.0.0.1
configure bgp restart both
conf bgp restart add address-family ipv6-unicast
create bgp neighbor 2001:db8:1::2 remote-as 200
enable bgp neighbor all capability ipv6-unicast
enable bgp neighbor all
enable bgp
```

To configure router EXOS-2, use the following commands:

```
create vlan bgp-restart
configure vlan bgp-restart add port 2:5
configure vlan bgp-restart ipaddress 2001:db8:1::2/48
enable ipforwarding ipv6
configure bgp as-number 200
configure bgp routerid 10.0.0.2
configure bgp restart aware-only
create bgp neighbor 2001:db8:1::1 remote-as 100
enable bgp neighbor all capability ipv6-unicast
enable bgp neighbor all
enable bgp
```

Route Reflector Example for IPv4

Figure 216 shows the network topology for this example.

Router 1.1.1.1 in this example is a regular BGP peer. To configure router 1.1.1.1 to connect to the route reflector as a regular BGP peer, use the following commands:

```
create vlan to_rr
configure vlan to_rr add port 1:1
configure vlan to_rr ipaddress 10.0.0.1/24
enable ipforwarding vlan to_rr

configure bgp router 1.1.1.1
configure bgp as-number 100
create bgp neighbor 10.0.0.2 remote-as 100
enable bgp
enable bgp neighbor all
```

To configure router 2.2.2.2, the route reflector, use the following commands:

```
create vlan to_nc
configure vlan to_nc add port 1:1
configure vlan to_nc ipaddress 10.0.0.2/24
enable ipforwarding vlan to_nc
```

```
create vlan to_c1
configure vlan to_c1 add port 1:2
configure vlan to_c1 ipaddress 10.0.2.2/24
enable ipforwarding vlan to_c1

create vlan to_c2
configure vlan to_c2 add port 1:2
configure vlan to_c2 ipaddress 10.0.3.2/24
enable ipforwarding vlan to_c2

configure bgp router 2.2.2.2
configure bgp as-number 100
create bgp neighbor 10.0.0.1 remote-as 100
create bgp neighbor 10.0.2.1 remote-as 100
create bgp neighbor 10.0.3.1 remote-as 100
configure bgp neighbor 10.0.2.1 route-reflector-client
configure bgp neighbor 10.0.3.1 route-reflector-client
enable bgp neighbor all
enable bgp
```

To configure route reflector client 3.3.3.3, use the following commands:

```
create vlan to_rr
configure vlan to_rr add port 1:1
configure vlan to_rr ipaddress 10.0.2.1/24
enable ipforwarding vlan to_rr

configure bgp router 3.3.3.3
configure bgp as-number 100
create bgp neighbor 10.0.2.2 remote-as 100
enable bgp neighbor all
enable bgp
```

To configure route reflector client 4.4.4.4, use the following commands:

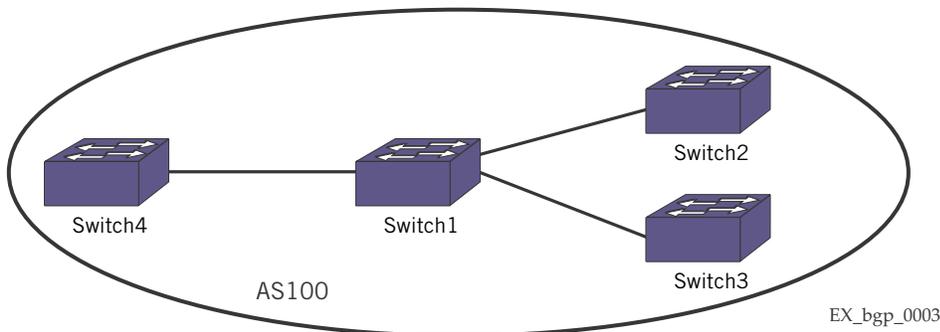
```
create vlan to_rr
configure vlan to_rr add port 1:1
configure vlan to_rr ipaddress 10.0.3.1/24
enable ipforwarding vlan to_rr

configure bgp router 4.4.4.4
configure bgp as-number 100
create bgp neighbor 10.0.3.2 remote-as 100
enable bgp neighbor all
enable bgp
```

Route Reflector Example for IPv6

Figure 219 shows the network topology for this example.

Figure 219: Route Reflector Example



In Figure 219, Switch1 is the route reflector, and Switch2 and Switch3 are route reflector clients. Switch4 is a regular neighbor (non-route-reflector client).

The following sections provide information on this example:

- [Route Reflector \(Switch1\) Configuration on page 1374](#)
- [Switch2 Route Reflector Client Configuration on page 1375](#)
- [Switch3 Route Reflector Client Configuration on page 1375](#)
- [Switch4 Configuration on page 1375](#)
- [Configuration Display for Switch1 on page 1376](#)
- [Configuration Display for Switch2 on page 1376](#)

Route Reflector (Switch1) Configuration

To configure the route reflector, enter the following commands:

```

create vlan "v3"
create vlan "v1"
create vlan "v2"
configure vlan v3 add ports 1:16
configure vlan v1 add ports 1:9
configure vlan v2 add ports 1:1
configure v1 ipaddress 2001:db8:1::1/48
configure v2 ipaddress 2001:db8:3::1/48
configure v3 ipaddress 2001:db8:5::1/484
enable ipforwarding ipv6
configure bgp AS-number 100
configure bgp routerid 1.1.1.1
create bgp neighbor 2001:db8:1::2 remote-AS-number 100
configure bgp neighbor 2001:db8:1::2 route-reflector-client
create bgp neighbor 2001:db8:3::2 remote-AS-number 100
configure bgp neighbor 2001:db8:3::2 route-reflector-client
create bgp neighbor 2001:db8:5::2 remote-AS-number 100
enable bgp neighbor 2001:db8:1::2 capability ipv6-unicast
enable bgp neighbor 2001:db8:3::2 capability ipv6-unicast
enable bgp neighbor 2001:db8:5::2 capability ipv6-unicast
  
```

```
enable bgp neighbor all
enable bgp
configure ospfv3 routerid 1.1.1.1
configure ospfv3 add vlan all area 0.0.0.0
enable ospfv3
```

Switch2 Route Reflector Client Configuration

To configure the Switch2 route reflector client, enter the following commands:

```
create vlan "v1"
configure vlan v1 add ports 1
configure v1 ipaddress 2001:db8:1::2/48
enable ipforwarding ipv6 vlan v1
configure bgp AS-number 100
configure bgp routerid 1.1.1.2
create bgp neighbor 2001:db8:1::1 remote-AS-number 100
enable bgp neighbor 2001:db8:1::1 capability ipv6-unicast
enable bgp neighbor 2001:db8:1::1
enable bgp
configure ospfv3 routerid 1.1.1.2
configure ospfv3 add vlan v1 area 0.0.0.0
enable ospfv3
```

Switch3 Route Reflector Client Configuration

To configure the Switch3 route reflector client, enter the following commands:

```
create vlan "v1"
configure vlan v1 add ports 1
configure v1 ipaddress 2001:db8:3::2/48
enable ipforwarding ipv6
configure bgp AS-number 100
configure bgp routerid 2.1.1.2
create bgp neighbor 2001:db8:3::1 remote-AS-number 100
enable bgp neighbor 2001:db8:3::1 capability ipv6-unicast
enable bgp neighbor 2001:db8:3::1
enable bgp
configure ospfv3 routerid 2.1.1.2
configure ospfv3 add vlan v1 area 0.0.0.0
enable ospfv3
```

Switch4 Configuration

Switch4 is not a route reflector client. To configure this switch, enter the following commands:

```
create vlan "net"
enable loopback-mode vlan net
create vlan "v1"
configure vlan v1 add ports 9
configure v1 ipaddress 2001:db8:5::2/48
configure net ipaddress 2001:db8:2555::1/48
enable ipforwarding ipv6
configure bgp AS-number 100
configure bgp routerid 5.1.1.2
configure bgp add network address-family ipv6-unicast 2001:db8:2555::/48
```

```

create bgp neighbor 2001:db8:5::1 remote-AS-number 100
enable bgp neighbor 2001:db8:5::1 capability ipv6-unicast
enable bgp neighbor 2001:db8:5::1
enable bgp
configure ospfv3 routerid 5.1.1.2
configure ospfv3 add vlan v1 area 0.0.0.0
enable ospfv3

```

Configuration Display for Switch1

The following display shows that the route reflector has two route reflector client peers (r flag), and one regular peer:

```
* Switch1.30 # show bgp neighbor
```

Peer	AS	Weight	State	InMsgs	OutMsgs(InQ)	Up/Down
Ier- 2001:db8:1::2	100	1	ESTABLISHED	6	8 (0)	0:0:04:03
Ier- 2001:db8:3::2	100	1	ESTABLISHED	5	7 (0)	0:0:02:51
Ie-- 2001:db8:5::2	100	1	ESTABLISHED	6	7 (0)	0:0:01:41

Flags: (d) disabled, (e) enabled, (E) external peer, (I) internal peer
(m) EBGP multihop, (r) route reflector client

BGP Peer Statistics

Total Peers	: 3		
EBGP Peers	: 0	IBGP Peers	: 3
RR Client	: 2	EBGP Multihop	: 0
Enabled	: 3	Disabled	: 0

Configuration Display for Switch2

The following command displays the BGP routes for route reflector client Switch2:

```
* Switch2.10 # show bgp routes address-family ipv6-unicast detail all
```

Routes:

```

Route: 2001:db8:2555::/48, Peer 2001:db8:1::1, BEST, Active
Origin IGP, Next-Hop 2001:db8:5::2, LPref 100, MED 0
Weight 1, RR Orig ID 5.1.1.2
As-PATH:
RR Cluster IDs: 1.1.1.1

```

BGP Route Statistics

Total Rxed Routes	: 1
Feasible Routes	: 1
Active Routes	: 1
Rejected Routes	: 0
Unfeasible Routes	: 0

Route Statistics on Session Type

```

Routes from Int Peer: 1
Routes from Ext Peer: 0

```

Route Confederation Example for IPv4

Figure 217 shows the network topology for this example.

To configure router A, use the following commands:

```
create vlan ab
configure vlan ab add port 1
configure vlan ab ipaddress 10.1.1.6/30
enable ipforwarding vlan ab
configure ospf add vlan ab area 0.0.0.0

create vlan ac
configure vlan ac add port 2
configure vlan ac ipaddress 10.1.1.17/30
enable ipforwarding vlan ac
configure ospf add vlan ac area 0.0.0.0
enable ospf

configure bgp as-number 64505
configure bgp routerid 10.1.1.17
configure bgp confederation-id 64500
enable bgp

create bgp neighbor 10.1.1.5 remote-AS-number 64505
create bgp neighbor 10.1.1.18 remote-AS-number 64505
enable bgp neighbor all
```

To configure router B, use the following commands:

```
create vlan ba
configure vlan ba add port 1
configure vlan ba ipaddress 10.1.1.5/30
enable ipforwarding vlan ba
configure ospf add vlan ba area 0.0.0.0

create vlan bc
configure vlan bc add port 2
configure vlan bc ipaddress 10.1.1.22/30
enable ipforwarding vlan bc
configure ospf add vlan bc area 0.0.0.0

create vlan bd
configure vlan bd add port 3
configure vlan bd ipaddress 10.1.1.9/30
enable ipforwarding vlan bd
configure ospf add vlan bd area 0.0.0.0
enable ospf

configure bgp as-number 64505
configure bgp routerid 10.1.1.22
configure bgp confederation-id 64500
enable bgp

create bgp neighbor 10.1.1.6 remote-AS-number 64505
create bgp neighbor 10.1.1.21 remote-AS-number 64505
create bgp neighbor 10.1.1.10 remote-AS-number 64510
```

```
configure bgp add confederation-peer sub-AS-number 64510
enable bgp neighbor all
```

To configure router C, use the following commands:

```
create vlan ca
configure vlan ca add port 1
configure vlan ca ipaddress 10.1.1.18/30
enable ipforwarding vlan ca
configure ospf add vlan ca area 0.0.0.0
```

```
create vlan cb
configure vlan cb add port 2
configure vlan cb ipaddress 10.1.1.21/30
enable ipforwarding vlan cb
configure ospf add vlan cb area 0.0.0.0
enable ospf
```

```
configure bgp as-number 64505
configure bgp routerid 10.1.1.21
configure bgp confederation-id 64500
enable bgp
```

```
create bgp neighbor 10.1.1.22 remote-AS-number 64505
create bgp neighbor 10.1.1.17 remote-AS-number 64505
enable bgp neighbor all
```

To configure router D, use the following commands:

```
create vlan db
configure vlan db add port 1
configure vlan db ipaddress 10.1.1.10/30
enable ipforwarding vlan db
configure ospf add vlan db area 0.0.0.0
```

```
create vlan de
configure vlan de add port 2
configure vlan de ipaddress 10.1.1.14/30
enable ipforwarding vlan de
configure ospf add vlan de area 0.0.0.0
enable ospf
```

```
configure bgp as-number 64510
configure bgp routerid 10.1.1.14
configure bgp confederation-id 64500
enable bgp
```

```
create bgp neighbor 10.1.1.9 remote-AS-number 64505
create bgp neighbor 10.1.1.13 remote-AS-number 64510
configure bgp add confederation-peer sub-AS-number 64505
enable bgp neighbor all
```

To configure router E, use the following commands:

```
create vlan ed
configure vlan ed add port 1
configure vlan ed ipaddress 10.1.1.13/30
enable ipforwarding vlan ed
```

```

configure ospf add vlan ed area 0.0.0.0
enable ospf

configure bgp as-number 64510
configure bgp routerid 10.1.1.13
configure bgp confederation-id 64500
enable bgp

create bgp neighbor 10.1.1.14 remote-AS-number 64510
enable bgp neighbor 10.1.1.14

```

Route Confederation Example for IPv6

Figure 201 shows the network topology for this example.

To configure router A, use the following commands:

```

create vlan ab
configure vlan ab add port 23
configure vlan ab ipaddress 2001:db8:1::6/48
enable ipforwarding ipv6 vlan ab
configure ospf add vlan ab area 0.0.0.0
create vlan ac
configure vlan ac add port 16
configure vlan ac ipaddress 2001:db8:3::17/48
enable ipforwarding ipv6 vlan ac
configure ospfv3 routerid 10.1.1.17
configure ospfv3 add vlan ac area 0.0.0.0
enable ospfv3
configure bgp as-number 65001
configure bgp routerid 10.1.1.17
configure bgp confederation-id 200
create bgp neighbor 2001:db8:1::5 remote-AS-number 65001
create bgp neighbor 2001:db8:3::18 remote-AS-number 65001
enable bgp neighbor all capability ipv6-unicast
enable bgp neighbor all
enable bgp

```

To configure router B, use the following commands:

```

configure default delete port all
create vlan ba
configure vlan ba add port 5:33
configure vlan ba ipaddress 2001:db8:1::5/48
enable ipforwarding ipv6 vlan ba
configure ospf add vlan ba area 0.0.0.0
create vlan bc
configure vlan bc add port 5:8
configure vlan bc ipaddress 2001:db8:2::22/48
enable ipforwarding ipv6 vlan bc
configure ospf add vlan bc area 0.0.0.0
create vlan bd
configure vlan bd add port 5:4
configure vlan bd ipaddress 2001:db8:4::9/48
enable ipforwarding ipv6 vlan bd
configure ospfv3 add vlan bd area 0.0.0.0

```

```
configure ospfv3 routerid 10.1.1.22
enable ospfv3
configure bgp as-number 65001
configure bgp routerid 10.1.1.22
configure bgp confederation-id 200
create bgp neighbor 2001:db8:1::6 remote-AS-number 65001
create bgp neighbor 2001:db8:2::21 remote-AS-number 65001
create bgp neighbor 2001:db8:4::10 remote-AS-number 65002
configure bgp add confederation-peer sub-AS-number 65002
enable bgp neighbor all capability ipv6-unicast
enable bgp neighbor all
enable bgp
```

To configure router C, use the following commands:

```
configure default delete port all
create vlan ca
configure vlan ca add port 2:16
configure vlan ca ipaddress 2001:db8:3::18/48
enable ipforwarding ipv6 vlan ca
configure ospfv3 add vlan ca area 0.0.0.0
create vlan cb
configure vlan cb add port 2:5
configure vlan cb ipaddress 2001:db8:2::21/48
enable ipforwarding ipv6 vlan cb
configure ospfv3 add vlan cb area 0.0.0.0
configure ospfv3 routerid 10.1.1.21
enable ospfv3
configure bgp as-number 65001
configure bgp routerid 10.1.1.21
configure bgp confederation-id 200
create bgp neighbor 2001:db8:2::22 remote-AS-number 65001
create bgp neighbor 2001:db8:3::17 remote-AS-number 65001
enable bgp neighbor all capability ipv6-unicast
enable bgp neighbor all
enable bgp
```

To configure router D, use the following commands:

```
configure default delete port all
create vlan db
configure vlan db add port 13
configure vlan db ipaddress 2001:db8:4::10/48
enable ipforwarding ipv6 vlan db
configure ospf add vlan db area 0.0.0.0
create vlan de
configure vlan de add port 5
configure vlan de ipaddress 2001:db8:5::14/48
enable ipforwarding ipv6 vlan de
configure ospfv3 add vlan de area 0.0.0.0
configure ospfv3 routerid 10.1.1.14
enable ospfv3
configure bgp as-number 65002
configure bgp routerid 10.1.1.14
configure bgp confederation-id 200
create bgp neighbor 2001:db8:4::9 remote-AS-number 65001
create bgp neighbor 2001:db8:5::13 remote-AS-number 65002
configure bgp add confederation-peer sub-AS-number 65001
```

```
enable bgp neighbor all capability ipv6-unicast
enable bgp neighbor all
enable bgp
```

To configure router E, use the following commands:

```
configure default delete port all
create vlan ed
configure vlan ed add port 5
configure vlan ed ipaddress 2001:db8:5::13/48
enable ipforwarding ipv6 vlan ed
configure ospfv3 add vlan ed area 0.0.0.0
configure ospfv3 routerid 10.1.1.13
enable ospfv3
configure bgp as-number 65002
configure bgp routerid 10.1.1.13
configure bgp confederation-id 200
create bgp neighbor 2001:db8:5::14 remote-AS-number 65002
enable bgp neighbor all capability ipv6-unicast
enable bgp neighbor all
enable bgp
```

Default Route Origination Example for IPv4

The following example configures the originate default route feature for BGP neighbor *10.203.134.5* using policy *def_originate.pol*.

```
def_originate.pol

entry prefix_matching {
    if match any {
        nlri 192.168.3.0/24;
    } then {
        as-path "64505";
        permit;
    }
}

enable bgp neighbor 10.203.134.5 originate-default policy def_originate
```

With this configuration, a default route is originated and sent to neighbor *10.203.134.5* only if there is a BGP route in the local RIB which matches the statement `nlri 192.168.3.0/24`. If a matching route exists, the default route is sent to neighbor *10.203.134.5* with the `64505` as-path prepended. If this is an EBGp neighbor, then the local AS-Number is prepended *after* `64505`.

If the route for the match statement `nlri 192.168.3.0/24` goes away and there is no other matching route in the BGP RIB, the default route origination feature becomes inactive and BGP withdraws the `0.0.0.0/0` default route from neighbor *10.203.134.5*. When a matching route becomes available again in the local BGP RIB, the default route origination feature becomes active again and the default route `0.0.0.0/0` is advertised to neighbor *10.203.134.5*.

Default Route Origination Example for IPv6

The following example configures the originate default route feature for BGP neighbor 2001:db8:1::2 using policy def_originate.pol.

```
def_originate.pol

entry prefix_matching {
    if match any {
        nlri 2001:db8:2::/48;
    } then {
        as-path "65001";
        permit;
    }
}

enable bgp neighbor 2001:db8:1::2 address-family ipv6-unicast originate-default policy
def_originate
```

With this configuration, a default route is originated and sent to neighbor 2001:db8:1::2 only if there is a BGP route in the local RIB which matches the statement nlri 2001:db8:2::/48. If a matching route exists, the default route is sent to neighbor 2001:db8:1::2 with the 65001 as-path prepended. If this is an EBGp neighbor, then the local AS-Number is prepended after 65001.

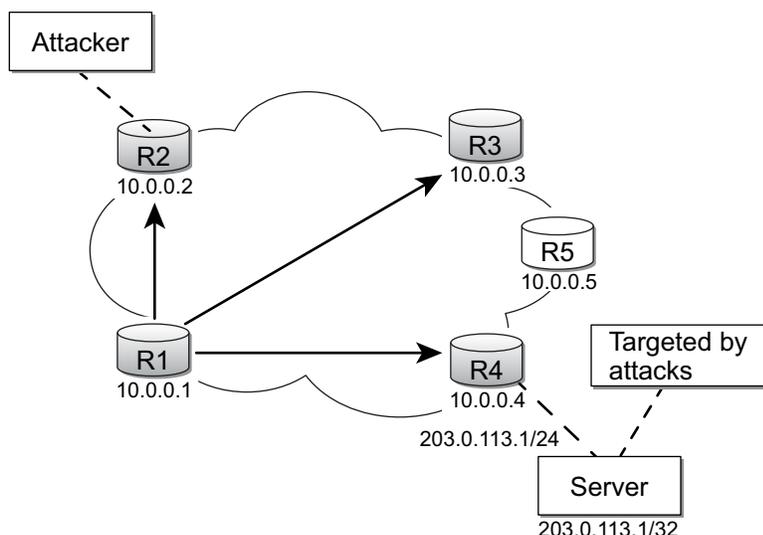
If the route for the match statement 2001:db8:2::/48 goes away and there is no other matching route in the BGP RIB, the default route origination feature becomes inactive and BGP withdraws the default route ::/0 from neighbor 2001:db8:1::2. When a matching route becomes available again in the local BGP RIB, the default route origination feature becomes active again and the default route ::/0 is advertised to neighbor 2001:db8:1::2.

BGP Speaker Black Hole Example

Black hole routing is used to protect a service provider's internal network from distributed denial of service (DDoS) attacks. The strategy is to drop inbound DDoS attack traffic destined to a target network at the edge of the provider network as soon as the target is identified.

Since the attack traffic may enter the service provider network from any of its edge routers, it is not feasible to manually configure a static black hole route entry on each edge router. The problem is further complicated by the fact that the target network, and the need to block traffic to it, is dynamic. Also, the service provider may serve multiple customers and you don't want to drop traffic to a customer network until it is identified as a target for an ongoing attack.

Instead, a service provider can use BGP to distribute a black hole route (route entry for the target network with a black hole next-hop) from a single router to all its edge BGP speakers that will then drop traffic destined to the victim's network right at the provider edge. [Figure 220](#) shows an example topology to achieve this.

Figure 220: Black Hole Routing Using BGP

Step 1

Prior to the attack, select an address for the intended black hole next-hop. Configure the forwarding plane of each edge router so that packets forwarded to this next-hop are dropped:

- 1 Create a black hole VLAN with an IP address that is in the same subnet as the chosen black hole next-hop.
- 2 Add an active port to the black hole VLAN (usually an unused port in the switch).
- 3 Create a static FDB entry that maps a well-chosen, unused MAC address to the black hole VLAN and the active port added to that VLAN.
- 4 Create a static ARP entry that maps the black hole next-hop to the above MAC address.
- 5 Create an ACL filter to deny packets that exit the blackhole VLAN.

In the following example configuration, 192.168.2.0/24 is the subnet of the black hole VLAN, “BH_VLAN,” and 192.168.2.66 is the chosen black hole next-hop. The active port 6:9 is added as the egress port for “BH_VLAN.”

```
create vlan BH_VLAN
configure vlan BH_VLAN tag 666
enable loopback-mode vlan BH_VLAN
configure vlan BH_VLAN ipaddress 192.168.2.1 255.255.255.0
enable ipforwarding vlan BH_VLAN
disable igmp snooping vlan BH_VLAN
disable igmp vlan BH_VLAN
create fdbentry 00:02:03:04:05:06 vlan BH_VLAN port 6:9
configure iparp add 192.168.2.66 vr VR-Default 00:02:03:04:05:06
configure access-list BH_ACL vlan BH_VLAN egress
```

When a packet arrives in the forwarding plane and looks up a route that has the above black hole next-hop as its next-hop, a subsequent ARP and FDB look-up occurs that forwards the packet to exit the switch using the above black hole VLAN, “BH_VLAN,” and port “6:9.” The packet is dropped due to the deny action in the egress ACL filter.

The following policy file discards any traffic that exits the black hole VLAN, “BH_VLAN.” Note that the match on “source-address 0.0.0.0/0” matches any egress packet ensuring that all packets exiting via the black hole VLAN are dropped:

```
edit policy BH_ACL
entry bh-acl {
    if {
        source-address 0.0.0.0/0;
    } then {
        deny ;
    }
}
```

Step 2

Prior to the attack, configure inbound route-maps on all edge BGP speakers (R2 through R4 in [Figure 220](#)). These inbound policies modify the next-hop of specifically marked BGP network layer reachability information (NLRIs) to point to the chosen black hole next-hop. We use BGP community or extended-community attributes to identify NLRIs that need to be black holed (ones whose next-hops have to be modified). The community values that are chosen should be reserved for this purpose within the provider network.

In the following example, a community of 666:0 is chosen for identifying blackhole routes. The next-hop of BGP NLRIs with that community attribute is modified to use the blackhole next-hop.

```
R3.1 # edit policy BH_policy_NH
entry bh-nhset {
    if match any {
        community 666:0;
        nlri any/32 ;
    } then {
        next-hop 192.168.2.66 ;
        permit ;
    }
}
entry bh-default {
    if match any {
    } then {
        permit ;
    }
}
```

Step 3

Once the target network has been identified during a DDoS attack, apply an outbound policy or export policy to one router (in our example, R1) within the provider network so that the route to the target network is advertised to the other edge routers within the community 666:0.

The following example creates a static route on R1 to the target network 203.0.113.1/32 with a static export policy that applies to the community. When the attack targets change, you only need to create or delete static routes to the target networks. The policy exports them to the edge BGP speakers with the selected community attribute values attached.

```
R1.1 # edit policy BH_COMM_APPLY
```

```

entry bh-comm-apply {
  if match any {
    nlri 203.0.113.0/24;
    nlri any/32;
  } then {
    community set "666:0";
  }
}
R1.2 # configure iproute add 203.0.113.1/32 10.0.0.6
R1.3 # enable bgp export static export-policy BH_COMM_APPLY

```

Alternatively, you can apply the policy as an outbound policy as below:

```

R1.10 # configure bgp neighbor 10.0.0.2 route-policy out BH_COMM_APPLY
R1.11 # configure bgp neighbor 10.0.0.3 route-policy out BH_COMM_APPLY
R1.12 # configure bgp neighbor 10.0.0.4 route-policy out BH_COMM_APPLY

```

Output

```

R4.67 # show bgp route all
Routes:

```

Destination	Peer	Next-Hop	LPref	Weight	MED	AS-Path
*>i 192.51.100.0/28	10.0.0.1	10.0.0.1	100	1	0	64500
*>i 192.51.100.16/28	10.0.0.1	10.0.0.1	100	1	0	64500
*>i 192.51.100.32/28	10.0.0.1	10.0.0.1	100	1	0	64500
*>i 192.51.100.48/28	10.0.0.1	10.0.0.1	100	1	0	64500
*>i 192.51.100.64/28	10.0.0.1	10.0.0.1	100	1	0	64500
*>i 203.0.113.1/32	10.0.0.1	192.168.2.66	100	1	0	64500

```

Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
(s) Stale, (m) Multipath, (u) Unfeasible
Origin: (?) Incomplete, (e) EGP, (i) IGP
BGP Route Statistics
Total Rxed Routes : 6
Feasible Routes : 6
Active Routes : 6
Rejected Routes : 0
Unfeasible Routes : 0
Route Statistics on Session Type
Routes from Int Peer: 0
Routes from Ext Peer: 6

```

```
Switch.68 # rtlookup 203.0.113.1
```

Ori	Destination	Gateway	Mtr	Flags	VLAN	Duration
#be	203.0.113.1/32	192.168.2.66	1	UG-D---um--f	BH_VLAN	0d:1h:5m:5s



NOTE

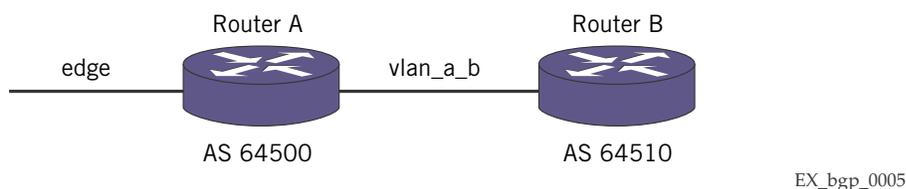
For the above solution, the edge routers, R1 through R4, may still export the route to the target network to external AS(s), but the traffic is dropped at the edge of the provider network.

An alternative solution for protecting the network is to perform step 1 only on a designated sink router, (R5 in [Figure 220](#)) and redistributes the black hole next-hop using iBGP to R2 through R4. When traffic arrives at routers R2 through R4, it is forwarded to R5, since R2–R4 have iBGP routes that resolve the black hole next-hop to R5. Router R5 then discards the traffic.

BGP Route Filtering Example for IPv4

You can use policy files with BGP attributes to filter IPv4 routes. The example in this section is for the topology shown in [Figure 221](#).

Figure 221: BGP IPv4 Route Filtering Example



The following sections describe the configuration and review of BGP filtering operation in the presented example:

- [Router A Configuration on page 1386](#)
- [Router B Configuration on page 1387](#)
- [BGP Routes Before Policy Application on page 1387](#)
- [Creating and Applying the Route Filter Policy on page 1387](#)
- [BGP Routes After Policy Application on page 1388](#)

Router A Configuration

```

configure vlan default delete ports all
create vlan "vlan_a_b"
create vlan "edge"
configure vlan vlan_a_b add ports 5 untagged
configure vlan edge add ports 23 untagged
configure vlan edge ipaddress 10.10.10.1/24
enable ipforwarding vlan edge
configure vlan vlan_a_b ipaddress 10.20.20.1/24
enable ipforwarding vlan vlan_a_b

configure bgp AS-number 64500
configure bgp routerid 10.10.10.1
enable bgp community format AS-number:number
create bgp neighbor 10.10.10.2 remote-AS-number 64505
enable bgp neighbor 10.10.10.2
create bgp neighbor 10.20.20.2 remote-AS-number 64510
enable bgp neighbor 10.20.20.2
enable bgp neighbor 10.10.10.2 soft-in-reset
configure bgp neighbor 10.20.20.2 send-community both
enable bgp
  
```

Router B Configuration

```

create vlan "vlan_B_A"
configure vlan vlan_B_A add ports 25 untagged
configure vlan vlan_B_A ipaddress 10.20.20.2/24
enable ipforwarding vlan vlan_B_A

configure bgp AS-number 64510
configure bgp routerid 10.20.20.2
enable bgp community format AS-number:number
create bgp neighbor 10.20.20.1 remote-AS-number 64500
enable bgp neighbor 10.20.20.1
enable bgp

```

BGP Routes Before Policy Application

The following example shows the routes in the BGP routing table at Router A after completing the configuration described in the previous two sections:

```
* Switch.52 # show bgp route all
```

Routes:

	Destination	Peer	Next-Hop	LPref	Weight	MED	AS-Path
*>i	172.16.1.0/24	10.10.10.2	10.10.10.2	100	1	0	64505
*>i	10.1.1.0/24	10.10.10.2	10.10.10.2	100	1	0	64505 64496
0							
*>i	10.1.2.0/24	10.10.10.2	10.10.10.2	100	1	0	64505 64496
0							
*>i	10.1.3.0/24	10.10.10.2	10.10.10.2	100	1	0	64505 64496
0							
*>i	10.1.34.0/24	10.10.10.2	10.10.10.2	100	1	0	64505 64499

Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
(s) Stale, (m) Multipath, (u) Unfeasible

Origin: (?) Incomplete, (e) EGP, (i) IGP

BGP Route Statistics

```

Total Rxed Routes : 5
Feasible Routes   : 5
Active Routes     : 5
Rejected Routes   : 0
Unfeasible Routes : 0

```

Route Statistics on Session Type

```

Routes from Int Peer: 0
Routes from Ext Peer: 5

```

Creating and Applying the Route Filter Policy

The policy described in this section is applied to Router A and does the following:

- Denies routes in network 172.16.1.0/24
- Sets the values of community and MED for routes in network 10.1.0.0/16
- Sets the values of community and MED for routes that contains AS path 64499

The following is a route filter policy named *custFilter*:

```
entry et1 {
    if match all {
        nlri 172.16.1.0/24;
    } then {
        deny;
    }
}
entry et2 {
    if match any {
        nlri 10.1.0.0/16;
        as-path 64499;
    } then {
        med set 100;
        community set "2342:6788";
        permit;
    }
}
```

To apply the *custFilter* inbound policy, use the following command:

```
* (pacman) DUTA.53 # configure bgp neighbor 10.10.10.2 route-policy in custfilter
```

BGP Routes After Policy Application

The following example shows the routes in the BGP routing table at Router A after applying the *custFilter* inbound policy:

```
* Switch.55 # show bgp route all
```

Routes:

Destination	Peer	Next-Hop	LPref	Weight	MED	AS-Path
*>i 10.1.1.0/24	10.10.10.2	10.10.10.2	100	1	100	64505 64496
0						
*>i 10.1.2.0/24	10.10.10.2	10.10.10.2	100	1	100	64505 64496
0						
*>i 10.1.3.0/24	10.10.10.2	10.10.10.2	100	1	100	64505 64496
0						
*>i 10.1.34.0/24	10.10.10.2	10.10.10.2	100	1	100	64505 64499

Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
(s) Stale, (m) Multipath, (u) Unfeasible

Origin: (?) Incomplete, (e) EGP, (i) IGP

BGP Route Statistics

```
Total Rxed Routes : 5
Feasible Routes   : 4
Active Routes     : 4
Rejected Routes   : 1
Unfeasible Routes : 0
```

Route Statistics on Session Type

```
Routes from Int Peer: 0
Routes from Ext Peer: 4
```

Route 172.16.1.0/24 is not present in the BGP routing table shown above. The next example shows that the MED and community values are set as defined in the policy.

```
* Switch.56 # show bgp route detail all

Routes:
Route: 10.1.1.0/24, Peer 10.10.10.2, BEST, Active
Origin IGP, Next-Hop 10.10.10.2, LPref 100, MED 100
Weight 1,
As-PATH: 64505 64496 0
Community: 2342:6788

Route: 10.1.2.0/24, Peer 10.10.10.2, BEST, Active
Origin IGP, Next-Hop 10.10.10.2, LPref 100, MED 100
Weight 1,
As-PATH: 64505 64496 0
Community: 2342:6788

Route: 10.1.3.0/24, Peer 10.10.10.2, BEST, Active
Origin IGP, Next-Hop 10.10.10.2, LPref 100, MED 100
Weight 1,
As-PATH: 64505 64496 0
Community: 2342:6788

Route: 10.1.34.0/24, Peer 10.10.10.2, BEST, Active
Origin IGP, Next-Hop 10.10.10.2, LPref 100, MED 100
Weight 1,
As-PATH: 64505 64499
Community: 2342:6788

BGP Route Statistics
  Total Rxed Routes : 5
  Feasible Routes   : 4
  Active Routes     : 4
  Rejected Routes   : 1
  Unfeasible Routes : 0
Route Statistics on Session Type
  Routes from Int Peer: 0
  Routes from Ext Peer: 4
```

To view the routes that are denied at Router A, use the following command:

```
* Switch.57 # show bgp neighbor 10.10.10.2 rejected-routes all

Rejected Routes:
  Destination      Peer           Next-Hop       LPref Weight MED   AS-Path
-----
  i 172.16.1.0/24  10.10.10.2    10.10.10.2    0     1     0     64505

Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
       (s) Stale, (m) Multipath, (u) Unfeasible

Origin: (?) Incomplete, (e) EGP, (i) IGP
```

BGP Route Statistics

```
Total Rxed Routes : 5
Rejected Routes   : 1
Unfeasible Routes : 0
```

The next command example shows the denied route as an inactive route. The routes were updated because *soft-reset* is configured for this neighbor.

```
* Switch.61 # show bgp neighbor 10.10.10.2 received-routes all
```

Routes:

	Destination	Peer	Next-Hop	LPref	Weight	MED	AS-Path
	Destination	Peer	Next-Hop	LPref	Weight	MED	AS-Path
i	172.16.1.0/24	10.10.10.2	10.10.10.2	0	1	0	64505
*>i	10.1.1.0/24	10.10.10.2	10.10.10.2	100	1	100	64505 64496
0							
*>i	10.1.2.0/24	10.10.10.2	10.10.10.2	100	1	100	64505 64496
0							
*>i	10.1.3.0/24	10.10.10.2	10.10.10.2	100	1	100	64505 64496
0							
*>i	10.1.34.0/24	10.10.10.2	10.10.10.2	100	1	100	64505 64499

```
Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
        (s) Stale, (m) Multipath, (u) Unfeasible
```

```
Origin: (?) Incomplete, (e) EGP, (i) IGP
```

BGP Route Statistics

```
Total Rxed Routes : 5
Feasible Routes    : 4
Active Routes      : 4
Rejected Routes    : 1
Unfeasible Routes  : 0
```

The following command examples show that the denied routes are not transmitted to the neighbors:

```
* Switch.58 # show bgp neighbor 10.20.20.2 transmitted-routes all
```

Advertised Routes:

	Destination	Next-Hop	LPref	Weight	MED	AS-Path
>i	10.1.1.0/24	10.20.20.1	0		100	64500 64505
64496						0
>i	10.1.2.0/24	10.20.20.1	0		100	64500 64505
64496						0
>i	10.1.3.0/24	10.20.20.1	0		100	64500 64505
64496						0
>i	10.1.34.0/24	10.20.20.1	0		100	64500 64505
64499						

```
Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
        (s) Stale, (m) Multipath, (u) Unfeasible
```

```
Origin: (?) Incomplete, (e) EGP, (i) IGP
```

BGP Route Statistics

```
Advertised Routes : 4
```

```
* Switch.59 # show bgp neighbor 10.20.20.2 transmitted-routes detail all
```

```
Advertised Routes:
```

```
Route: 10.1.1.0/24, Active
Origin IGP, Next-Hop 10.20.20.1, MED 100
As-PATH: 64500 64505 64496 0
```

```
Route: 10.1.2.0/24, Active
Origin IGP, Next-Hop 10.20.20.1, MED 100
As-PATH: 64500 64505 64496 0
```

```
Route: 10.1.3.0/24, Active
Origin IGP, Next-Hop 10.20.20.1, MED 100
As-PATH: 64500 64505 64496 0
```

```
Route: 10.1.34.0/24, Active
Origin IGP, Next-Hop 10.20.20.1, MED 100
As-PATH: 64500 64505 64499
```

```
BGP Route Statistics
```

```
  Advertised Routes : 4
```

BGP Route Filtering Example for IPv6

You can use policy files with BGP attributes to filter IPv6 routes. The example in this section is for the topology shown in [Figure 221](#).

The following sections describe the configuration and review of BGP filtering operation in the presented example:

- [Router A Configuration on page 1391](#)
- [Router B Configuration on page 1392](#)
- [BGP Routes Before Policy Application on page 1392](#)
- [Creating and Applying the Route Filter Policy on page 1393](#)
- [BGP Routes After Policy Application on page 1394](#)

Router A Configuration

```
configure vlan default delete ports all
create vlan "a_b"
enable ipforwarding ipv6 vlan a_b
create vlan "edge"
enable ipforwarding ipv6 vlan edge
configure vlan a_b add ports 5 untagged
configure vlan edge add ports 23 untagged
configure edge ipaddress 2001:db8:2000::1/48
configure a_b ipaddress 2001:db8:3000::1/48

configure bgp AS-number 2100
configure bgp routerid 10.10.10.1
enable bgp community format AS-number:number
create bgp neighbor 2001:db8:2000::2 remote-AS-number 1100
```

```

enable bgp neighbor 2001:db8:2000::2
create bgp neighbor 2001:db8:3000::2 remote-AS-number 3300
enable bgp neighbor 2001:db8:3000::2
enable bgp neighbor 2001:db8:2000::2 capability ipv6-unicast
enable bgp neighbor 2001:db8:2000::2 address-family ipv6-unicast soft-in-reset
enable bgp neighbor 2001:db8:2000::2 capability ipv6-multicast
configure bgp neighbor 2001:db8:3000::2 send-community both
enable bgp neighbor 2001:db8:3000::2 capability ipv6-unicast
enable bgp neighbor 2001:db8:3000::2 capability ipv6-multicast
enable bgp

```

Router B Configuration

```

configure vlan default delete ports all
create vlan "b_a"
enable ipforwarding ipv6 vlan b_a
configure vlan b_a add ports 25 untagged
configure b_a ipaddress 2001:db8:3000::2/48

configure bgp AS-number 3300
configure bgp routerid 10.20.20.2
enable bgp community format AS-number:number
create bgp neighbor 2001:db8:3000::1 remote-AS-number 2100
enable bgp neighbor 2001:db8:3000::1
enable bgp neighbor 2001:db8:3000::1 capability ipv6-unicast
enable bgp neighbor 2001:db8:3000::1 capability ipv6-multicast
enable bgp

```

BGP Routes Before Policy Application

The following example shows the routes in the BGP routing table at Router A after completing the configuration described in the previous two sections:

```
* Switch.122 # show bgp routes address-family ipv6-unicast all
```

Routes:

	Destination	LPref	Weight	MED
	Peer	Next-Hop		
	AS-Path			
*>i	2001:db8:4001::/48	100	1	0
	2001:db8:2000::2	2001:db8:2000::2		
	1100 5623			
*>i	2001:db8:4002::/48	100	1	0
	2001:db8:2000::2	2001:db8:2000::2		
	1100 5623			
*>i	2001:db8:4003::/48	100	1	0
	2001:db8:2000::2	2001:db8:2000::2		
	1100 5623			
*>i	2001:db8:5030::/48	100	1	0
	2001:db8:2000::2	2001:db8:2000::2		
	1100 4977			
*>i	2001:db8:5031::/48	100	1	0
	2001:db8:2000::2	2001:db8:2000::2		
	1100 4977			

```
*>i 2001:db8:a004::/48          100 1 0
    2001:db8:2000::2          2001:db8:2000::2
    1100
```

Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
(s) Stale, (m) Multipath, (u) Unfeasible

Origin: (?) Incomplete, (e) EGP, (i) IGP

BGP Route Statistics

```
Total Rxed Routes : 6
Feasible Routes   : 6
Active Routes     : 6
Rejected Routes   : 0
Unfeasible Routes : 0
```

Route Statistics on Session Type

```
Routes from Int Peer: 0
Routes from Ext Peer: 6
```

Creating and Applying the Route Filter Policy

The policy described in this section is applied to Router A and does the following:

- Denies routes in network 2001:db8:a004::/48
- Sets the *community* and *MED* values for routes in network 2001:db8:4000::/44
- Sets the *community* and *MED* values for routes that contain AS path 4977

The following is a route filter policy named *custFilter*:

```
entry et1 {
    if match all {
        nlri 2001:db8:a004::/48;
    } then {
        deny;
    }
}

entry et2 {
    if match any {
        nlri 2001:db8:4000::/44;
        as-path 4977;
    } then {
        med set 100;
        community set "2342:6788";
        permit;
    }
}
```

To apply the *custFilter* inbound policy, use the following command:

```
* Switch.53 # configure bgp neighbor 2001:db8:2000::1 ipv6-unicast route-policy in
custfilter
```

BGP Routes After Policy Application

The following example shows the routes in the BGP routing table at Router A after applying the *custFilter* inbound policy:

```
* Switch.127 # show bgp routes address-family ipv6-unicast all
```

Routes:

	Destination	LPref	Weight	MED
	Peer	Next-Hop		
	AS-Path			
*>i	2001:db8:4001::/48	100	1	100
	2001:db8:2000::2	2001:db8:2000::2		
	1100 5623			
*>i	2001:db8:4002::/48	100	1	100
	2001:db8:2000::2	2001:db8:2000::2		
	1100 5623			
*>i	2001:db8:4003::/48	100	1	100
	2001:db8:2000::2	2001:db8:2000::2		
	1100 5623			
*>i	2001:db8:5030::/48	100	1	100
	2001:db8:2000::2	2001:db8:2000::2		
	1100 4977			
*>i	2001:db8:5031::/48	100	1	100
	2001:db8:2000::2	2001:db8:2000::2		
	1100 4977			

Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
(s) Stale, (m) Multipath, (u) Unfeasible

Origin: (?) Incomplete, (e) EGP, (i) IGP

BGP Route Statistics

```
Total Rxed Routes : 6
Feasible Routes   : 5
Active Routes     : 5
Rejected Routes   : 1
Unfeasible Routes : 0
```

Route Statistics on Session Type

```
Routes from Int Peer: 0
Routes from Ext Peer: 5
```

Route 2001:db8:a004::/48 is not present in the BGP routing table shown above. The routes were updated because *soft-reset* is configured for this neighbor.

The following command examples show that the denied routes are not transmitted to the neighbors:

```
* Switch.130 # show bgp neighbor 2001:db8:3000::2 address-family ipv6-unicast
transmitted-routes all
```

Advertised Routes:

Destination	LPref	Weight	MED
>i 2001:db8:4001::/48	0		100
Peer	Next-Hop		
AS-Path			
-----	-----		
2100 1100 5623	2001:db8:3000::1		
>i 2001:db8:4002::/48	0		100
Peer	Next-Hop		
AS-Path			
-----	-----		
2100 1100 5623	2001:db8:3000::1		
>i 2001:db8:4003::/48	0		100
Peer	Next-Hop		
AS-Path			
-----	-----		
2100 1100 5623	2001:db8:3000::1		
>i 2001:db8:5030::/48	0		100
Peer	Next-Hop		
AS-Path			
-----	-----		
2100 1100 4977	2001:db8:3000::1		
>i 2001:db8:5031::/48	0		100
Peer	Next-Hop		
AS-Path			
-----	-----		
2100 1100 4977	2001:db8:3000::1		

Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
(s) Stale, (m) Multipath, (u) Unfeasible

Origin: (?) Incomplete, (e) EGP, (i) IGP

BGP Route Statistics

Advertised Routes : 5

The next example shows another way to see that the MED values are set as defined in the policy.

```
* Switch.131 # show bgp neighbor 2001:db8:3000::2 address-family ipv6-unicast
transmitted-routes detail all
```

Advertised Routes:

```
Route: 2001:db8:4001::/48, Active
Origin IGP, Next-Hop 2001:db8:3000::1, MED 100
As-PATH: 2100 1100 5623
```

```
Route: 2001:db8:4002::/48, Active
Origin IGP, Next-Hop 2001:db8:3000::1, MED 100
As-PATH: 2100 1100 5623
```

```
Route: 2001:db8:4003::/48, Active
Origin IGP, Next-Hop 2001:db8:3000::1, MED 100
As-PATH: 2100 1100 5623
```

```
Route: 2001:db8:5030::/48, Active
Origin IGP, Next-Hop 2001:db8:3000::1, MED 100
As-PATH: 2100 1100 4977
```

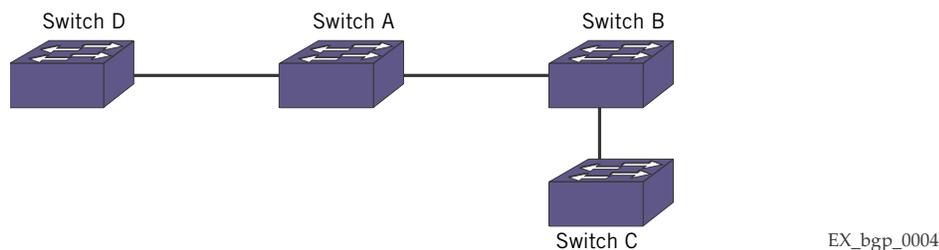
```
Route: 2001:db8:5031::/48, Active
Origin IGP, Next-Hop 2001:db8:3000::1, MED 100
As-PATH: 2100 1100 4977
```

```
BGP Route Statistics
  Advertised Routes : 5
```

Route Aggregation Example for IPV4

Figure 222 shows the topology for this example.

Figure 222: Route Aggregation Example



To configure router A, use the following commands:

```
create vlan "v3"
create vlan "v1"
create vlan "v2"
configure vlan v3 add ports 1
configure vlan v1 add ports 23
configure vlan v2 add ports 16
configure v1 ipaddress 10.1.1.1/24
configure v2 ipaddress 10.1.2.1/24
configure v3 ipaddress 10.1.4.1/24
enable ipforwarding
configure bgp AS-number 100
configure bgp routerid 1.1.1.1
create bgp neighbor 10.1.1.2 remote-AS-number 64500
create bgp neighbor 10.1.2.2 remote-AS-number 64505
create bgp neighbor 10.1.4.2 remote-AS-number 64510
enable bgp neighbor all
enable bgp
enable bgp aggregation
configure bgp add aggregate-address 172.16.0.0/16 as-set summary-only
```

To configure router B, use the following commands:

```
create vlan "v1"
create vlan "net"
configure vlan v1 add ports 5:33
configure vlan net add ports 5:20
configure v1 ipaddress 10.1.1.2/24
configure net ipaddress 172.16.1.1/24
enable ipforwarding
configure bgp AS-number 64500
configure bgp routerid 1.1.1.2
configure bgp add network address-family 172.16.1.0/24
create bgp neighbor 10.1.1.1 remote-AS-number 100
```

```
enable bgp neighbor 10.1.1.1
enable bgp
```

To configure router C, use the following commands:

```
create vlan "v1"
create vlan "net"
configure vlan net add ports 2:15
configure vlan v1 add ports 2:16
configure v1 ipaddress 10.1.2.2/24
configure net ipaddress 172.16.2.1/24
enable ipforwarding
configure bgp AS-number 64505
configure bgp routerid 2.1.1.2
configure bgp add network 172.16.2.0/24
create bgp neighbor 10.1.2.1 remote-AS-number 100
enable bgp neighbor 10.1.2.1
enable bgp
```

To configure router D, use the following commands:

```
create vlan "v1"
configure vlan v1 add ports 24
configure v1 ipaddress 10.1.4.2/24
enable ipforwarding
configure bgp AS-number 64510
configure bgp routerid 5.1.1.2
create bgp neighbor 10.1.4.1 remote-AS-number 100
enable bgp neighbor 10.1.4.1
enable bgp
```

The following command displays the aggregated route at Router D:

```
* Switch.22 # show bgp routes all
```

```
Routes:
```

Destination	Peer	Next-Hop	LPref	Weight	MED	AS-Path

--						
*>i 172.16.0.0/16	10.1.4.1	10.1.4.1	100	1	0	100
300						

```
Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
        (s) Stale, (m) Multipath, (u) Unfeasible
```

```
Origin: (?) Incomplete, (e) EGP, (i) IGP
```

```
BGP Route Statistics
```

```
Total Rxed Routes : 1
Feasible Routes    : 1
Active Routes      : 1
Rejected Routes    : 0
Unfeasible Routes  : 0
```

```
Route Statistics on Session Type
```

```
Routes from Int Peer: 0
Routes from Ext Peer: 1
```

Route Aggregation Example for IPv6

Figure 222 shows the topology for this example.

To configure router A, use the following commands:

```
create vlan "v3"
create vlan "v1"
create vlan "v2"
configure vlan v3 add ports 1
configure vlan v1 add ports 23
configure vlan v2 add ports 16
configure v1 ipaddress 2001:db8:1::1/48
configure v2 ipaddress 2001:db8:3::1/48
configure v3 ipaddress 2001:db8:5::1/48
enable ipforwarding ipv6
configure bgp AS-number 100
configure bgp routerid 1.1.1.1
create bgp neighbor 2001:db8:1::2 remote-AS-number 200
create bgp neighbor 2001:db8:3::2 remote-AS-number 300
create bgp neighbor 2001:db8:5::2 remote-AS-number 400
enable bgp neighbor all
enable bgp neighbor all capability ipv6-unicast
enable bgp
enable bgp aggregation
configure bgp add aggregate-address address-family ipv6-unicast 2001::/16 as-set
summary-only
```

To configure router B, use the following commands:

```
create vlan "v1"
create vlan "net"
configure vlan v1 add ports 5:33
configure vlan net add ports 5:20
configure v1 ipaddress 2001:db8:1::2/48
configure net ipaddress 2001:db8:2222::1/48
enable ipforwarding ipv6
configure bgp AS-number 200
configure bgp routerid 1.1.1.2
configure bgp add network address-family ipv6-unicast 2001:db8:2222::/48
create bgp neighbor 2001:db8:1::1 remote-AS-number 100
enable bgp neighbor 2001:db8:1::1 capability ipv6-unicast
enable bgp neighbor 2001:db8:1::1
enable bgp
```

To configure router C, use the following commands:

```
create vlan "v1"
create vlan "net"
configure vlan net add ports 2:15
configure vlan v1 add ports 2:16
configure v1 ipaddress 2001:db8:3::2/48
configure net ipaddress 2001:db8:2333::2/48
enable ipforwarding ipv6
configure bgp AS-number 300
configure bgp routerid 2.1.1.2
configure bgp add network address-family ipv6-unicast 2001:db8:2333::/48
create bgp neighbor 2001:db8:3::1 remote-AS-number 100
```

```
enable bgp neighbor 2001:db8:3::1 capability ipv6-unicast
enable bgp neighbor 2001:db8:3::1
enable bgp
```

To configure router D, use the following commands:

```
create vlan "v1"
configure vlan v1 add ports 24
configure v1 ipaddress 2001:db8:5::2/48
enable ipforwarding ipv6
configure bgp AS-number 400
configure bgp routerid 5.1.1.2
create bgp neighbor 2001:db8:5::1 remote-AS-number 100
enable bgp neighbor 2001:db8:5::1 capability ipv6-unicast
enable bgp neighbor 2001:db8:5::1
enable bgp
```

The following command displays the aggregated route at Router D:

```
* (Engineering) X250e-24t.23 # sh bgp routes address-family ipv6-unicast all
```

Routes:

Destination	LPref	Weight	MED
Peer	Next-Hop		
AS-Path			

*>i 2001::/16	100	1	0
2001:db8:5::1	2001:db8:5::1		
100 { 200 300 }			

Flags: (*) Preferred BGP route, (>) Active, (d) Suppressed, (h) History
(s) Stale, (m) Multipath, (u) Unfeasible

Origin: (?) Incomplete, (e) EGP, (i) IGP

BGP Route Statistics

```
Total Rxed Routes : 1
Feasible Routes   : 1
Active Routes     : 1
Rejected Routes   : 0
Unfeasible Routes : 0
```

Route Statistics on Session Type

```
Routes from Int Peer: 0
Routes from Ext Peer: 1
```


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CHAPTER

Multicast Routing and Switching

This chapter includes the following sections:

- [Overview on page 1402](#)
- [Multicast Table Management on page 1402](#)
- [PIM Overview on page 1404](#)
- [IGMP Overview on page 1411](#)
- [Configuring IP Multicast Routing on page 1416](#)
- [Multicast VLAN Registration on page 1425](#)
- [Displaying Multicast Information on page 1436](#)
- [Troubleshooting PIM on page 1437](#)

For more information on IP multicasting, refer to the following publications:

- RFC 1112—*Host Extension for IP Multicasting*
- RFC 2236—*Internet Group Management Protocol, Version 2*
- RFC 3569—*SSM for IPv4/IPv6* (only for IPv4)
- PIM-SM Version 2—*draft-ietf-pim-sm-v2-new-05*
- RFC 4601—*PIM SM* (only for IPv4)
- PIM-SM for IPv4/IPv6 (only for IPv4)
- RFC 2362 PIM-SM (Edge Mode)
- RFC 3973 PIM-DM (only for IPv4)
- RFC 3569—*draft-ietf-ssm-arch-06.txt PIM-SSM PIM Source Specific Multicast*
- PIM-DM Draft IETF Dense Mode—*draft-ietf-idmr-pimdm-05.txt, draft-ietf-pim-dm-new-v2-04.txt*
- RFC 3376—*Internet Group Management Protocol, Version 3*

The following URL points to the website for the IETF PIM Working Group:

<http://www.ietf.org/html.charters/pim-charter.html>

Overview

Multicast routing and switching is the functionality of a network that allows a single host (the multicast server) to send a packet to a group of hosts. With multicast, the server is not forced to duplicate and send enough packets for all the hosts in a group. Instead, multicast allows the network to duplicate the packet where needed to supply the group. Multicast greatly reduces the bandwidth required to send data to a group of hosts. IP multicast routing is a function that allows multicast traffic to be forwarded from one subnet to another across a routing domain.

IP multicast routing requires the following functions:

- A router that can forward IP multicast packets
- A router-to-router multicast routing protocol (for example, Protocol Independent Multicast (PIM)) to discover multicast routes
- A method for the IP host to communicate its multicast group membership to a router (for example, Internet Group Management Protocol (IGMP))



NOTE

You should configure IP unicast routing before you configure IP multicast routing.

Multicast Table Management

The ExtremeXOS software uses the following tables to support IP multicast traffic:

- IPv4 multicast route table
- L3 hash table
- IP multicast VLAN table
- IP multicast group table

The following sections provide more information on IP multicast tables and their management:

- [IPv4 Multicast Route Table on page 1402](#)
- [Support for Additional L3 Hash Table Entries on page 1403](#)
- [Support for Additional IP Multicast Group Table Entries on page 1403](#)
- [Capacity Restrictions for Mixed Mode Installations on page 1404](#)

IPv4 Multicast Route Table

Beginning with Release 12.1, all IP multicast routes are stored and maintained in the software multicast route table. Routes are added to the multicast route table from the following sources:

- Multicast static routes (configured manually by the network administrator)
- Multicast dynamic routes (learned through protocols such as MBGP and MISIS)

The multicast route table is used for reverse path forwarding (RPF) checks, not for packet forwarding. The switch uses RPF checks to avoid multicast forwarding loops. When a multicast packet is received, the switch does an RPF lookup, which checks the routing tables to see if the packet arrived on the

interface on which the router would send a packet to the source. The switch forwards only those packets that arrive on the interface specified for the source in the routing tables.

The RPF lookup uses the multicast routing table first, and if no entry is found for the source IP address, the RPF lookup uses the unicast routing table.

**NOTE**

Because the multicast routing table is used only for RPF checks (and not for routing), IP route compression and ECMP do not apply to multicast routes in the multicast routing table.

**NOTE**

Beginning with ExtremeXOS software version 12.1, the route metric is no longer used to select between multicast and unicast routes. If the RPF lookup finds a route in the multicast table, that route is used. The unicast routing table is used only when no route is found in the multicast table.

The advantage to having separate routing tables for unicast and multicast traffic is that the two types of traffic can be separated, using different paths through the network.

Support for Additional L3 Hash Table Entries

The L3 hash table is introduced in [“Introduction to Hardware Forwarding Tables” on page 1209](#). The L3 hash table stores entries for IPv4 routes, IPv4 and IPv6 hosts, and IPv4 and IPv6 multicast groups. To make more space available in the L3 hash table for IPv4 and IPv6 multicast groups, you can do the following:

- Configure the extended IPv4 host cache feature to move IPv4 local and remote routes to the LPM table as described in [“Extended IPv4 Host Cache” on page 1209](#).
- Configure BlackDiamond 8900 xl-series modules or Summit X480 series switches to do one of the following:
 - Move IPv4 local and remote hosts to the external LPM table.
 - Move IPv6 local hosts to the external LPM table.
 - Move IPv4 local and remote hosts to the external LPM table and support IPv4 multicast entries in the external LPM table.

For more information, see the description for the `configure forwarding external-tables` command.

**NOTE**

To benefit from the use of the external LPM tables, you must leave the IP multicast compression feature enabled, which is the default setting.

Support for Additional IP Multicast Group Table Entries

The IP multicast group table specifies the egress ports for Layer 2 and Layer 3 multicast traffic groups. To make more space available in the IP multicast group table, you can do the following:

- Leave IP multicast compression enabled (it is enabled by default).
- Use the following I/O modules, which provide higher capacity tables:
 - BlackDiamond 8900 xl-series modules
 - BlackDiamond 8900-G96T-c

Capacity Restrictions for Mixed Mode Installations

A mixed mode installation is a switch configuration that contains I/O modules with different table sizes. The actual table capacity for the switch is set to that supported on the I/O module with the smallest tables. To increase the capacity of IP multicast tables, all I/O modules must support the minimum table size you want.

If you add a higher-capacity I/O module to a switch that has been running with lower capacity modules, the switch generates a message and adjusts the table capacity on the higher-capacity card to that of the lower-capacity card.

PIM Overview

The switch supports both dense mode and sparse mode operation. You can configure dense mode or sparse mode on a per-interface basis. After they are enabled, some interfaces can run dense mode, while others run sparse mode.

The switch also supports PIM snooping. The following sections provide additional information on PIM:

- [PIM Edge Mode on page 1404](#)
- [PIM Dense Mode on page 1405](#)
- [PIM Sparse Mode on page 1406](#)
- [PIM Mode Interoperation on page 1407](#)
- [PIM Source Specific Multicast on page 1407](#)
- [PIM Snooping on page 1409](#)

PIM Edge Mode

PIM Edge Mode is a subset of PIM that operates with the following restrictions:

- The switch does not act as a candidate rendezvous point (CRP).
- The switch does not act as a candidate bootstrap router (CBSR).
- At most, two active PIM-SM interfaces are permitted. There is no restriction on the number of passive interfaces (within the limit of the maximum IP interfaces).
- Only PIM Sparse Mode (PIM-SM) is supported.



NOTE

This feature is supported at and above the license level listed for this feature in the license tables in [Appendix A, “Feature License Requirements.”](#)

Active PIM interfaces can have other PIM enabled routers on them. Passive interfaces should only have hosts sourcing or receiving multicast traffic.

PIM Dense Mode

Protocol-Independent Multicast - Dense Mode (PIM-DM) is a multicast routing protocol. A new feature, called PIM-DM state refresh, creates two PIM-DM operating modes, which are described in the following sections:

- [PIM-DM Without State Refresh on page 1405](#)
- [PIM-DM with State Refresh on page 1406](#)



NOTE

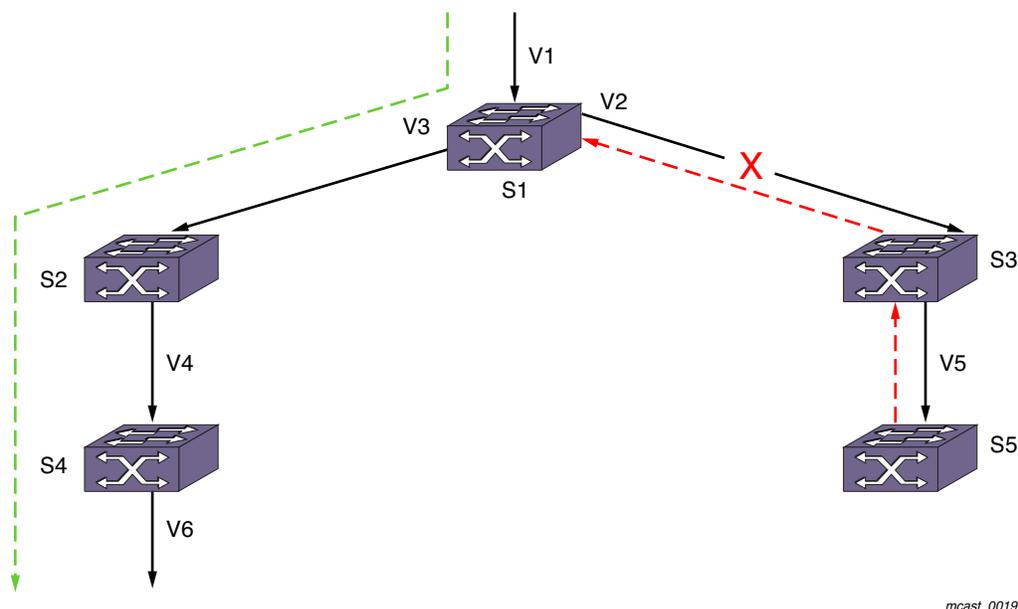
For additional information on PIM-DM, see *RFC 3973, Protocol Independent Multicast - Dense Mode (PIM-DM): Protocol Specification*.

PIM-DM Without State Refresh

PIM-DM is a broadcast and prune protocol, which means that multicast servers initially broadcast traffic to all destinations, and then switches later *prune* paths on which there are no receivers.

Figure 223 shows a dense mode multicast tree with an active branch and a pruned branch.

Figure 223: PIM-DM Operation



mcast_0019

In Figure 223, multicast traffic is flowing from VLAN *V1* connected to switch *S1*. *S1* floods multicast traffic to both neighbors *S2* and *S3* which in turn flood multicast traffic to *S4* and *S5*. *S4* has IGMP members, so it floods multicast traffic down to VLAN *V6*. *S5*, which has no multicast members, sends a prune upstream towards the source. The green line shows the flow of traffic on the active branch, and the red line shows the prune sent upstream for the pruned branch. After outgoing interface *V2* is

pruned from the multicast tree, subsequent multicast traffic from *S1* flows only through *S2* and *S4* and is not forwarded to *S3*.

After *S3* sends a prune upstream, *S3* starts a *prune hold time* timer on outgoing interface *V5*. When this timer expires, *S3* adds *V5* back to the multicast egress list and sends a graft upstream to pull multicast traffic down again. When multicast traffic arrives from *S1*, it is forwarded to *S5*, which repeats the upstream prune message because it still has no members. This prune, time-out, and flood process repeats as long as the traffic flow exists and no members are on the pruned branch, and this process consumes bandwidth during every cycle.



NOTE

This feature is supported at and above the license level listed for this feature in the license tables in [Appendix A, “Feature License Requirements.”](#)

PIM-DM routers perform reverse path multicasting (RPM). However, instead of exchanging its own unicast route tables for the RPM algorithm, PIM-DM uses the existing unicast routing table for the reverse path. As a result, PIM-DM requires less system memory.

PIM-DM with State Refresh

The PIM-DM State Refresh feature keeps the PIM-DM prune state from timing out by periodically sending a *state refresh* control message down the source tree. These control messages reset the *prune hold time* timer on each pruned interface and prevent the bandwidth waste that occurs with each prune, time-out, and flood cycle.

When a topology change occurs, the PIM-DM State Refresh feature improves network convergence. For example, suppose that an S, G entry on *S5* in [Figure 223](#) is removed due to non-availability of a route. Without PIM-DM State Refresh, multicast traffic is blocked for minutes (due to a time-out on the upstream routers). In the meantime if an IGMP member or a PIM-DM neighbor joins *S5*, there is no way to pull traffic down immediately because *S5* does not have any S, G information. State refresh control messages solve this problem by indicating S, G state information periodically to all downstream routers. When *S5* receives a state refresh from *S3*, it scans the S, G information and all pending requests from PIM-DM neighbors and IGMP members. If there are pending requests for the group in the state refresh message, *S5* can immediately send a graft message upstream to circumvent the upstream timers and pull multicast traffic to its members and neighbors.

To enable, configure, and disable the PIM-DM State Refresh feature, use the following commands:

```
configure pim state-refresh {vlan} [<vlannname> | all] [on | off]
configure pim state-refresh timer origination-interval <interval>
configure pim state-refresh timer source-active-timer <interval>
configure pim state-refresh ttl <ttlvalue>
```

PIM Sparse Mode

Unlike PIM-DM, Protocol-Independent Multicast - Sparse Mode (PIM-SM) is an explicit join and prune protocol, which means that multicast receivers, and the routers that support them, must join multicast groups before they receive multicast traffic. When all receivers on a network branch leave a multicast group, that branch is *pruned* so that the multicast traffic does not continue to consume bandwidth on that branch. PIM-SM supports shared trees as well as shortest path trees (SPTs). PIM-SM is beneficial for large networks that have group members that are sparsely distributed.

**NOTE**

This feature is supported at and above the license level listed for this feature in the license tables in [Appendix A, "Feature License Requirements."](#)

Using PIM-SM, the router sends a join message to the rendezvous point (RP). The RP is a central multicast router that is responsible for receiving and distributing the initial multicast packets. You can configure a dynamic or static RP.

When a router has a multicast packet to distribute, it encapsulates the packet in a unicast message and sends it to the RP. The RP decapsulates the multicast packet and distributes it among all member routers.

When a router determines that the multicast rate has exceeded a configured threshold, that router can send an explicit join to the originating router. When this occurs, the receiving router gets the multicast directly from the sending router and bypasses the RP.

**NOTE**

You can run either PIM-DM or PIM-SM per virtual LAN (VLAN).

PIM Mode Interoperation

An Extreme Networks switch can function as a PIM multicast border router (PMBR). A PMBR integrates PIM-SM and PIM-DM traffic.

When forwarding PIM-DM traffic into a PIM-SM network, the PMBR acts as a virtual first hop and encapsulates the initial traffic for the RP. The PMBR forwards PIM-DM multicast packets to the RP, which, in turn, forwards the packets to those routers that have joined the multicast group.

The PMBR also forwards PIM-SM traffic to a PIM-DM network, based on the (*.*.RP) entry. The PMBR sends a (*.*.RP) join message to the RP, and the PMBR forwards traffic from the RP into the PIM-DM network.

No commands are required to enable PIM mode interoperation. PIM mode interoperation is automatically enabled when a dense mode interface and a sparse mode interface are enabled on the same switch.

PIM Source Specific Multicast

PIM-SM works well in many-to-many multicasting situations. For example, in video conferencing, each participating site multicasts a stream that is sent to all the other participating sites. However, PIM-SM is overly complex for one-to-many multicast situations, such as multimedia content distribution or streaming stock quotes. In these and similar applications, the listener is silent and can know the source of the multicast in advance, or can obtain it. In these situations, there is no need to join an RP, as the join request can be made directly towards the source.

**NOTE**

This feature is supported at and above the license level listed for this feature in the license tables in [Appendix A, “Feature License Requirements.”](#)

PIM Source Specific Multicast (PIM-SSM) is a special case of PIM-SM, in which a host explicitly sends a request to receive a stream from a specific source, rather than from any source.

IGMPv3 hosts can use PIM SSM directly, because the ability to request a stream from a specific source first became available with IGMPv3. The PIM-SSM capable router interprets the IGMPv3 message to initiate a PIM-SM join towards the source.

**NOTE**

IGMPv1 and IGMPv2 hosts can use PIM SSM if IGMP-SSM mapping is enabled and configured on the ExtremeXOS switch. For more information, see [“Using IGMP-SSM Mapping” on page 1414.](#)

PIM-SSM has the following advantages:

- No overhead of switching to the source-specific tree and waiting for the first packet to arrive
- No need to learn and maintain an RP
- Fewer states to maintain on each router
- No need for the complex register mechanism from the source to the RP
- Better security, as each stream is forwarded from sources known in advance

PIM-SSM has the following requirements:

- Any host that participates directly in PIM-SSM must use IGMPv3.
- To support IGMPv1 and IGMPv2 hosts, IGMP-SSM mapping must be enabled and configured.

PIM-SSM is designed as a subset of PIM-SM and all messages are compliant with PIM-SM. PIM-SSM and PIM-SM can coexist in a PIM network; only the last hop router need to be configured for PIM-SSM if both source and receivers are present all the time. However, to avoid any JOIN delay, it is recommended that you enable all routers along the (s,g) path for PIM-SSM.

Configuring the PIM-SSM Address Range

A range of multicast addresses is used for PIM-SSM. Within that address range, non-IGMPv3 messages are ignored, and any IGMPv3 exclude messages are ignored. These messages are ignored for all router interfaces, even those not configured for PIM-SSM. By default there is no PIM-SSM range specified on the router. If you choose the default keyword in the CLI when specifying the PIM-SSM range, you configure the range 232.0.0.0/8. You can also choose to specify a different range for PIM-SSM by using a policy file.

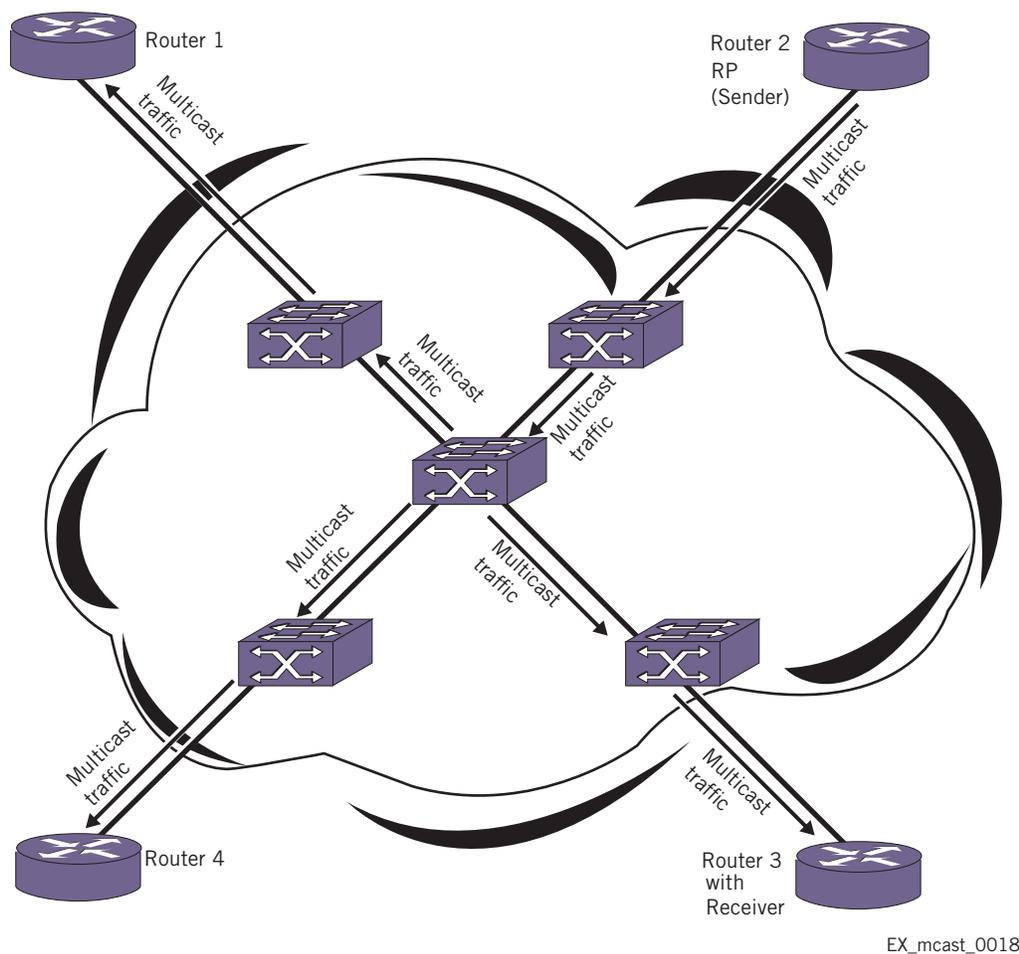
To configure the PIM-SSM address range, use the following command:

```
configure pim ssm range [default | policy <policy-name>]
```

PIM Snooping

PIM snooping provides a solution for handling multicast traffic on a shared media network more efficiently. In networks where routers are connected to a L2 switch, multicast traffic is essentially treated as broadcast traffic (see [Figure 224](#)).

Figure 224: Multicast Without PIM Snooping



IGMP snooping does not solve this flooding issue when routers are connected to a L2 switch. Switch ports are flooded with multicast packets. PIM snooping addresses this flooding behavior by efficiently replicating multicast traffic only onto ports which routers advertise the PIM join requests (see [Figure 225](#)).

IGMP Overview

IGMP is a protocol used by an IP host to register its IP multicast group membership with a router. A host that intends to receive multicast packets destined for a particular multicast address registers as a member of that multicast address group. Periodically, the router queries the multicast group to see if the group is still in use. If the group is still active, a single IP host responds to the query, and group registration is maintained.

IGMPv2 is enabled by default on the switch, and the ExtremeXOS software supports IGMPv3. However, the switch can be configured to disable the generation of periodic IGMP query packets. IGMP should be enabled when the switch is configured to perform IP multicast routing.

IETF standards require that a router accept and process IGMPv2 and IGMPv3 packets only when the router-alert option is set in received IGMP packets. By default, the ExtremeXOS software receives and processes all IGMP packets, regardless of the setting of the router-alert option within a packet. When the switch will be used with third-party switches that expect IETF compliant behavior, use the following commands to manage this feature:

```
configure igmp router-alert receive-required [on | off] {{vlan} <vlan_name>}
configure igmp router-alert transmit [on | off] {{vlan} <vlan_name>}
```

By default, IGMP report/leave message for the local multicast address (224.0.0.x/24 groups) will always have the router-alert option set, regardless of IGMP router-alert transmit option (on and off) setting by the user.

IGMPv3, specified in RFC 3376, adds support for source filtering. Source filtering is the ability for a system to report interest in receiving packets only from specific source addresses (filter mode include) or from all sources except for specific addresses (filter mode exclude). IGMPv3 is designed to be interoperable with IGMPv1 and IGMPv2.



NOTE

The ExtremeXOS software supports IGMPv3 source include mode filtering, but it does not support IGMPv3 specific source exclude mode filtering.

The following sections provide information on IGMP features:

- [IGMP Snooping on page 1411](#)
- [Static IGMP on page 1412](#)
- [IGMP Snooping Filters on page 1413](#)
- [Limiting the Number of Multicast Sessions on a Port on page 1414](#)
- [Enabling and Disabling IGMP Snooping Fast Leave on page 1414](#)
- [Using IGMP-SSM Mapping on page 1414](#)

IGMP Snooping

IGMP snooping is a Layer 2 function of the switch; it does not require multicast routing to be enabled. In IGMP snooping, the Layer 2 switch keeps track of IGMP reports and only forwards multicast traffic to that part of the local network that requires it. IGMP snooping optimizes the use of network bandwidth and prevents multicast traffic from being flooded to parts of the local network that do not need it. The switch does not reduce any IP multicast traffic in the local multicast domain (224.0.0.x).

IGMP snooping is enabled by default on all VLANs and VMANs in the switch. If IGMP snooping is disabled on a VLAN or VMAN, all IGMP and IP multicast traffic floods within the VLAN or VMAN. IGMP snooping expects at least one device on every VLAN to periodically generate IGMP query messages.

To enable or disable IGMP snooping, use the following commands:

```
enable igmp snooping {forward-mcrouter-only | {vlan} <name> | with-proxy vr <vrname>}
```

```
disable igmp snooping {forward-mcrouter-only | with-proxy | vlan <name>}
```

**NOTE**

IGMP snooping is not supported on SVLANs on any platform.

When a port sends an IGMP leave message, the switch removes the IGMP snooping entry after 1000 milliseconds (the leave time is configurable, ranging from 0 to 175000 ms). The switch sends a query to determine which ports want to remain in the multicast group. If other members of the VLAN want to remain in the multicast group, the switch ignores the leave message, but the port that requests removal is removed from the IGMP snooping table.

If the last port within a VLAN sends an IGMP leave message and the switch does not receive any responses to the subsequent query, then the switch immediately removes the VLAN from the multicast group.

IGMP snooping is implemented primarily through ACLs, which are processed on the interfaces. These special purpose ACLs are called *IGMP snooping filters*. On Summit family switches and BlackDiamond 8800 series switches, the software allows you to choose between two types of IGMP snooping filters: per-port filters (the default) and per-VLAN filters.

The two types of IGMP snooping filters use switch hardware resources in different ways. The two primary hardware resources to consider when selecting the IGMP snooping filters are the Layer 3 multicast forwarding table and the interface ACLs. The size of both of these hardware resources is determined by the switch model. In general, the per-port filters consume more resources from the multicast table and less resources from the ACL table. The per-VLAN filters consume less space from the multicast table and more from the ACL table.

In Summit family switches and BlackDiamond 8800 series switches, using the per-port filters can fill up the multicast table and place an extra load on the CPU. To avoid this, configure the switch to use the per-VLAN filters.

**NOTE**

The impact of the per-VLAN filters on the ACL table increases with the number of VLANs configured on the switch. If you have a large number of configured VLANs, we suggest that you use the per-port filters.

Static IGMP

To receive multicast traffic, a host must explicitly join a multicast group by sending an IGMP report; then, the traffic is forwarded to that host. In some situations, you might like multicast traffic to be

forwarded to a port where a multicast-enabled host is not available (for example, when you test multicast configurations).

Static IGMP emulates a host or router attached to a switch port, so that multicast traffic is forwarded to that port, and the switch sends a proxy join for all the statically configured IGMP groups when an IGMP query is received. You can emulate a host to forward a particular multicast group to a port; and you may emulate a router to forward all multicast groups to a port. Static IGMP is only available with IGMPv2.

To emulate a host on a port, use the following command:

```
configure igmp snooping {vlan} <vlaname> ports <portlist> add static group <ip address>
```

To emulate a multicast router on a port, use the following command:

```
configure igmp snooping {vlan} <vlaname> ports <portlist> add static group <ip address>
```

To remove these entries, use the corresponding command:

```
configure igmp snooping {vlan} <vlaname> ports <portlist> delete static group [<ip_address> | all]
```

```
configure igmp snooping vlan <vlaname> ports <portlist> delete static router
```

To display the IGMP snooping static groups, use the following command:

```
show igmp snooping {vlan} <name> static [group | router]
```

IGMP Snooping Filters

IGMP snooping filters allow you to configure a policy file on a port to allow or deny IGMP report and leave packets coming into the port. (For details on creating policy files, see [“Policy Manager” on page 649](#).) The IGMP snooping filter feature is supported by IGMPv2 and IGMPv3.

For the policies used as IGMP snooping filters, all the entries should be IP address type entries, and the IP address of each entry must be in the class-D multicast address space but should not be in the multicast control subnet range (224.0.0.x/24).

Use the following template to create a snooping filter policy file that denies IGMP report and leave packets for the 239.11.0.0/16 and 239.10.10.4/32 multicast groups:

```
#
# Add your group addresses between "Start" and "end"
# Do not touch the rest of the file!!!!

entry igmpFilter {
    if match any {
#----- Start of group addresses -----
        nlri 239.11.0.0/16;
        nlri 239.10.10.4/32;
#----- end of group addresses -----
    } then {
        deny;
    }
}
```

```
entry catch_all {
    if {

        } then {
            permit;
        }
    }
}
```

After you create a policy file, use the following command to associate the policy file and filter to a set of ports:

```
configure igmp snooping vlan <vlaname> ports <portlist> filter [<policy> | none]
```

To remove the filter, use the `none` option.

To display the IGMP snooping filters, use the following command:

```
show igmp snooping {vlan} <name> filter
```

Limiting the Number of Multicast Sessions on a Port

The default configuration places no limit on the number of multicast sessions on each VLAN port. To place a limit on the number of sessions, use the following command:

```
configure igmp snooping {vlan} <vlaname> ports <portlist> set join-limit {<num>}
```

To remove a session limit, use the following command:

```
unconfigure igmp snooping {vlan} <vlaname> ports <portlist> set join-limit
```

Enabling and Disabling IGMP Snooping Fast Leave

When the fast leave feature is enabled and the last VLAN host leaves a multicast group, the router immediately removes the VLAN interface from the multicast group. The router does not query the VLAN for other members of the multicast group before removing group membership and the multicast interface.

The default setting for IGMP snooping fast leave is disabled. To enable the fast leave feature, use the following command:

```
enable igmp snooping {vlan} <name> fast-leave
```

To disable the fast leave feature, use the following command:

```
disable igmp snooping {vlan} <name> fast-leave
```

Using IGMP-SSM Mapping

IGMPv1 and IGMPv2 hosts can use PIM SSM if IGMP-SSM mapping is enabled and configured on the ExtremeXOS switch. When the router receives an IGMPv1 or IGMPv2 membership report for a group G, the router uses SSM mapping to determine one or more source IP addresses for group G. SSM mapping then interprets (not translates) the membership report as an IGMPv3 report and sends out PIM-SSM joins toward (S1, G) to (Sn, G).

When the router receives an IGMP Group leave message from a host, it sends out a group specific query (unless IGMP fast leave is configured) and continues to support joins for the corresponding (S1, G) to (Sn, G) channels. When the router does not get a response to the group specific query after a

time-out period, IGMP-SSM mapping informs PIM that the list of (S1, G) to (Sn, G) pairs should be considered for PIM prunes.

In a multi-access network (where more than one router is receiving IGMP messages from the hosts), only the designated router sends joins towards the source, so it is desirable to have same configuration for SSM group range and SSM Mapping range on all routers in a VLAN.



NOTE

When a group source exists on the same VLAN as a receiver, IGMP snooping causes the traffic to be L2 switched to the receiver, even if another source is available through IGMP SSM. This happens because the group mappings are stored in PIM, which is a L3 protocol.

The following sections provide additional information on IGMP-SSM mapping:

- [Limitations on page 1415](#)
- [Configuring IGMP-SSM Mapping on page 1415](#)
- [Displaying IGMP-SSM Mappings on page 1416](#)

Limitations

- IGMP SSM mapping support is provided for IPv4 only.
- PIM must be disabled on a switch to configure IGMP-SSM mapping.
- A single group address or range can be mapped to a maximum of 50 sources. If more than 50 sources are configured, the switch uses the 50 longest-matching prefixes.
- Extreme Networks recommends a maximum of 500 mappings per switch, but no limit is imposed by the software.

Configuring IGMP-SSM Mapping

To support PIM-SSM for IGMPv1 and IGMPv2 clients, a PIM-SSM range must be configured, and that range should include all groups to which the clients want access. If IGMPv1 and IGMPv2 clients request group addresses outside the PIM-SSM range, those addresses are ignored by PIM-SSM and forwarded to PIM as (*, G) requests.

To enable IGMP-SSM mapping, first configure a PIM-SSM range, and then enable IGMP-SSM mapping using the following commands:

```
configure pim ssm range [default | policy <policy-name>]
enable igmp ssm-map {vr <vr-name>}
```

To configure an IGMP-SSM mapping, use the following command:

```
configure igmp ssm-map add <group_ip> [<prefix> | <mask>] [<source_ip> |
<src_domain_name>] {vr <vr-name>}
```

To remove a single IGMP-SSM mapping, use the following command:

```
configure igmp ssm-map delete <group_ip> [/<prefix>} | <mask>] [<source_ip> | all] <vr
<vr-name>}
```

To remove all IGMP-SSM mappings on a virtual router, use the following command:

```
unconfigure igmp ssm-map {<vr <vr-name>}
```

To disable IGMP-SSM mapping on a virtual router, use the following command:

```
disable igmp ssm-map {vr <vr-name>}
```

Displaying IGMP-SSM Mappings

To see whether or not IGMP-SSM mapping is enabled or disabled and to view the configured mappings for a multicast IP address, use the command:

```
show igmp ssm-map {<group_ip>} {vr <vr-name>}
```

Configuring IP Multicast Routing

This section describes the following tasks:

- [Enabling Multicast Forwarding on page 1416](#)
- [Configuring PIM on page 1416](#)
- [Configuring Multicast Static Routes on page 1417](#)
- [Configuring EAPS Support for Multicast Traffic on page 1417](#)
- [PIM Configuration Examples on page 1418](#)

Enabling Multicast Forwarding

To enable IP multicast forwarding:

- 1 Configure the system for IP unicast routing.
- 2 Enable multicast forwarding on the interface using the following command:

```
enable ipmcfwding {vlan <name>}
```

Configuring PIM

To configure PIM multicast routing, enable multicast forwarding as described in “[Enabling Multicast Forwarding](#)” on page 1416 and do the following:

- 1 Configure PIM on all IP multicast routing interfaces using the following command:
- 2 To enable and configure the PIM-DM state refresh feature on one or all VLANs, use the following commands:
- 3 For PIM-SSM, specify the PIM-SSM range, enable IGMPv3, and enable PIM-SSM on the interfaces using the following commands:

```
configure pim add vlan [<vlan-name> | all] {dense | sparse} {passive}
```

```
configure pim state-refresh {vlan} [<vlanname> | all] [on | off]
configure pim state-refresh timer origination-interval <interval>
configure pim state-refresh timer source-active-timer <interval>
configure pim state-refresh ttl <ttlvalue>
```

```
configure pim ssm range [default | policy <policy-name>]
enable igmp {vlan <vlan name>} {IGMPv1 | IGMPv2 | IGMPv3}
enable pim ssm vlan [<vlan_name> | all]
```

4 Enable PIM on the router using the following command:

```
enable pim
```

Configuring Multicast Static Routes



NOTE

Multicast static routes are supported in the IPv4 address family, but not the IPv6 address family.

Static routes are used to reach networks not advertised by routers, and are manually entered into the routing table. You can use either of two commands to create multicast static routes. The recommended command is the following:

```
configure iproute add [<ipNetmask> | <ip_addr> <mask>] <gateway> {bfd} {metric}
{multicast | multicast-only | unicast | unicast-only} {vr <vrname>}
```

For example:

```
configure iproute add 55.1.10.0/24 44.1.12.33 multicast
```

The following command is still supported for backward compatibility with earlier ExtremeXOS software releases:

```
configure ipmroute add [<source-net>/<mask-len> | <source-net> <mask>] {{protocol}
<protocol>} <rpf-address> {<metric>} {vr <vr-name>}
```

In the following example, the `configure ipmroute add` command is used to specify protocol information for a route:

```
configure ipmroute add 58.1.10.0/24 ospf 44.1.12.33
```

When a static route is configured with protocol information, the route is shown as *UP* only when the protocol route is available. Otherwise, the route is *Down*. In the example above, the multicast static route 58.1.10.0/24 is shown as *UP* only when the OSPF route is available to reach the network 58.1.10.0/24.

Static routes are stored in the switch configuration and can be viewed with the `show configuration` command. Static multicast routes that do not include protocol information are displayed using the `configure iproute` command format, even if they were created using the `configure ipmroute` command. Static routes that are created with a protocol field are displayed using the `configure ipmroute` command format.

Configuring EAPS Support for Multicast Traffic

The ExtremeXOS software provides several commands for configuring how EAPS supports multicast traffic after an EAPS topology change. For more information, see the descriptions for the following commands:

- `configure eaps multicast add-ring-ports`
- `configure eaps multicast send-query`
- `configure eaps multicast temporary-flooding`

These commands apply for both IGMP and MLD.



NOTE

Using the old `configure eaps multicast send-igmp-query` command also applies for both IGMP and MLD. This command will be deprecated later.

Disabling IP Multicast Compression

The IP multicast compression feature is available only on Summit family switches and BlackDiamond 8000 series modules, and is enabled by default. You should only disable this feature if you suspect that switch processing resources are limited or if you think this feature is causing problems on the switch.

To disable or enable IP multicast compression, use the following command:

```
configure forwarding ipmc compression {group-table | off}
```

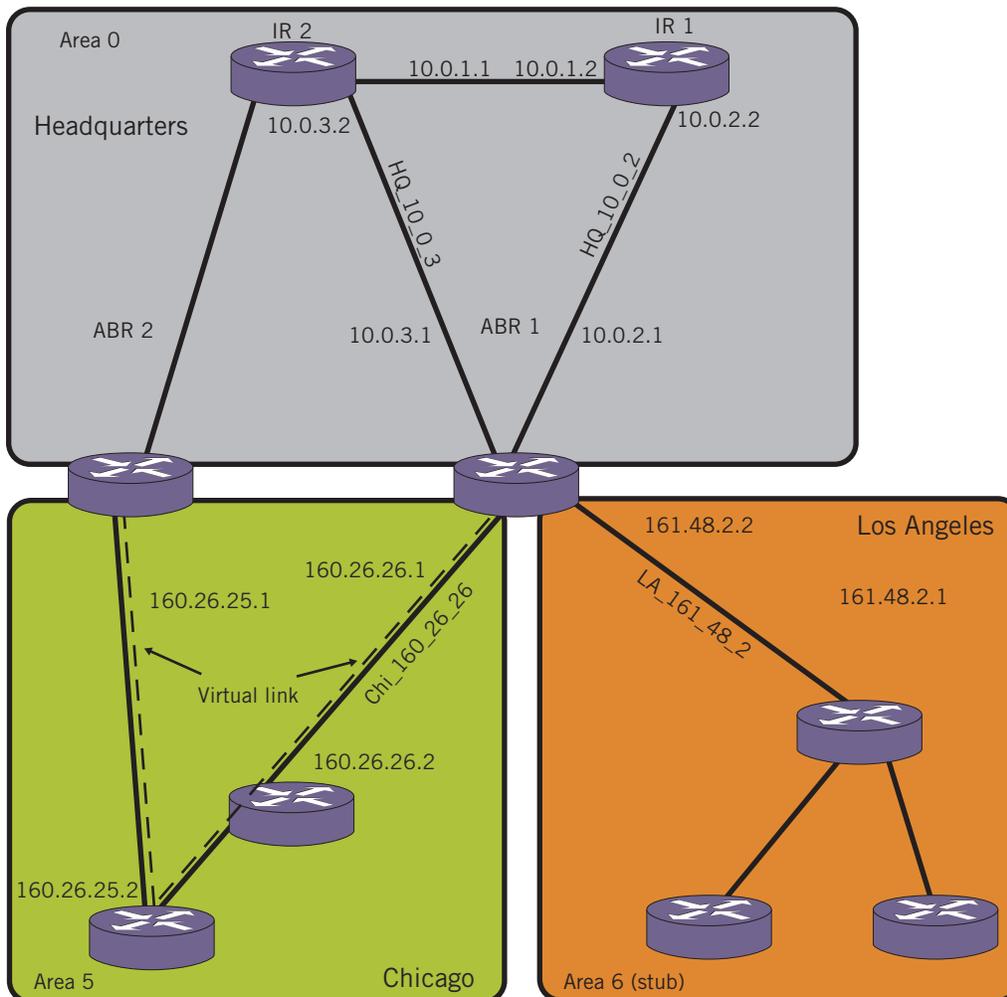
PIM Configuration Examples

This section provides the following examples:

- [PIM-DM Configuration Example on page 1418](#)
- [PIM-SM Configuration Example on page 1420](#)
- [PIM-SSM Configuration Example on page 1421](#)
- [PIM Snooping Configuration Example on page 1421](#)

PIM-DM Configuration Example

In [Figure 226](#), the system labeled IR 1 is configured for IP multicast routing, using PIM-DM.

Figure 226: IP Multicast Routing Using PIM-DM Configuration Example

EX_mcast_0016

**NOTE**

Figure 226 is used in Chapter 37, “OSPF,” to describe the Open Shortest Path First (OSPF) configuration on a switch. See Chapter 37 for more information about configuring OSPF.

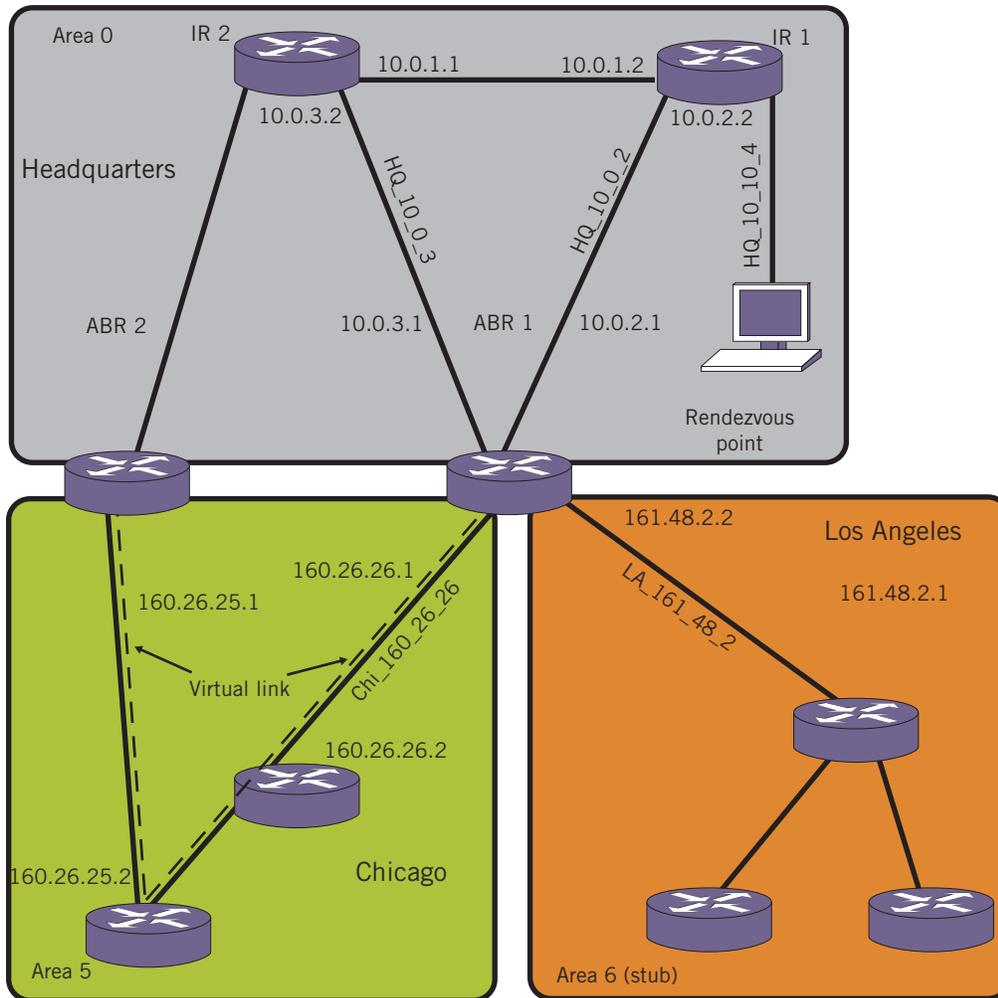
The router labeled IR1 has the following configuration:

```
configure vlan HQ_10_0_1 ipaddress 10.0.1.2 255.255.255.0
configure vlan HQ_10_0_2 ipaddress 10.0.2.2 255.255.255.0
configure ospf add vlan all area 0.0.0.0
enable ipforwarding
enable ospf
enable ipmcforwarding
configure pim add vlan all dense
enable pim
configure pim state-refresh vlan all on
```

PIM-SM Configuration Example

In [Figure 227](#), the system labeled ABR1 is configured for IP multicast routing using PIM-SM.

Figure 227: IP Multicast Routing Using PIM-SM Configuration Example



EX_mcast_0017



NOTE

[Figure 227](#) is used in Chapter 37, “OSPF,” to describe the Open Shortest Path First (OSPF) configuration on a switch. See Chapter 37 for more information about configuring OSPF.

The router labeled ABR1 has the following configuration:

```
configure vlan HQ_10_0_2 ipaddress 10.0.2.1 255.255.255.0
configure vlan HQ_10_0_3 ipaddress 10.0.3.1 255.255.255.0
configure vlan LA_161_48_2 ipaddress 161.48.2.2 255.255.255.0
configure vlan CHI_160_26_26 ipaddress 160.26.26.1 255.255.255.0
configure ospf add vlan all area 0.0.0.0
```

```

enable ipforwarding
enable ipmcforwarding
configure pim add vlan all sparse
tftp TFTP_SERV -g -r rp_list.pol
configure pim crp HQ_10_0_3 rp_list 30
configure pim cbsr HQ_10_0_3 30

```

The policy file, `rp_list.pol`, contains the list of multicast group addresses serviced by this RP. This set of group addresses are advertised as candidate RPs. Each router then elects the common RP for a group address based on a common algorithm. This group to RP mapping should be consistent on all routers.

The following is a policy file that configures the CRP for the address ranges 239.0.0.0/24 and 232.144.27.0:

```

entry extremel {
    if match any {
    }
    then {
        nlri 239.0.0.0/24 ;
        nlri 232.144.27.0/24 ;
    }
}

```

PIM-SSM Configuration Example

In the following example, the default PIM-SSM range of 232.0.0.0/8 is configured. For all interfaces, non-IGMPv3 messages and IGMPv3 exclude messages are ignored for addresses in this range. Hosts that use IGMPv3 on VLAN v13 can request and receive source specific multicast streams for addresses in the PIM-SSM range.

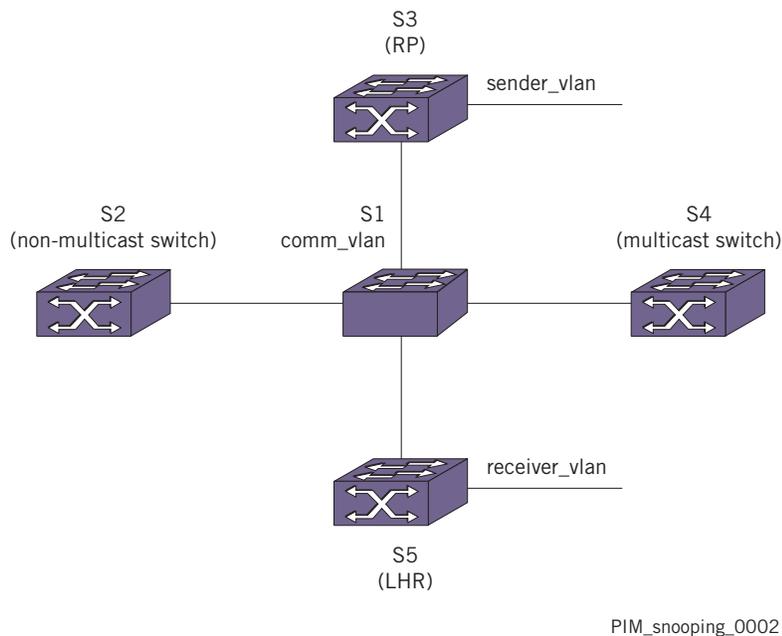
```

create vlan v12
create vlan v13
configure v12 add port 1
configure v13 add port 2
configure v12 ipaddress 12.1.1.1/24
configure v13 ipaddress 11.1.1.1/24
configure pim add vlan all sparse
enable ipforwarding
enable ipmcforwarding
enable igmp IGMPv3
configure pim ssm range default
enable pim ssm vlan v13
enable pim

```

PIM Snooping Configuration Example

Figure 228 shows a network configuration that supports PIM snooping.

Figure 228: PIM Snooping Configuration Example

In [Figure 228](#), Layer 3 switches *S2*, *S3*, *S4*, and *S5* are connected using the Layer 2 switch *S1* through the VLAN *comm_vlan*. Switches *S3*, *S4*, and *S5* are multicast capable switches, and switch *S2* is a non-multicast capable switch, which has no multicast routing protocol running.

Without PIM snooping, any ingress multicast data traffic on *comm_vlan* is flooded to all the switches, including switch *S2*, which does not support multicast traffic. IGMP snooping does not reduce flooding because it floods the multicast traffic to all router ports.

The network design calls for most multicast traffic to egress switch *S5*. PIM snooping helps by intercepting the PIM joins received from the downstream routers and forwarding multicast traffic only to those ports that received PIM joins.

The following sections provide additional information for this example:

- [Switch S1 \(PIM Snooping Switch\) Configuration Commands on page 1422](#)
- [Switch S3 Configuration Commands on page 1423](#)
- [Switch S5 Configuration Commands on page 1423](#)
- [Switch S4 Configuration Commands on page 1423](#)
- [Switch S2 Configuration Commands on page 1424](#)
- [PIM Snooping Example Configuration Displays on page 1424](#)

Switch S1 (PIM Snooping Switch) Configuration Commands. The following is an example configuration for the PIM snooping switch *S1*:

```
create vlan comm_vlan
configure vlan comm_vlan add port 1,2,3,4
disable igmp snooping
disable igmp_snooping comm_vlan

enable pim snooping
enable pim snooping comm_vlan
```

Switch S3 Configuration Commands. The following is an example configuration for switch S3, which also serves as an RP:

```
create vlan comm_vlan
configure vlan comm_vlan add port 1
configure comm_vlan ipa 10.172.168.4/24
enable ipforwarding comm_vlan
enable ipmcforwarding comm._vlan
configure pim add vlan comm_vlan sparse
configure ospf add vlan comm._vlan area 0.0.0.0

create vlan sender_vlan
configure vlan sender_vlan add port 2
configure sender_vlan ipa 10.172.169.4/24
enable ipforwarding comm_vlan
enable ipmcforwarding comm._vlan
configure pim add vlan comm._vlan sparse
configure ospf add vlan comm_vlan area 0.0.0.0

enable pim
enable ospf

configure pim crp static 10.172.169.4 pim_policy // RP is configured using the policy
pim_policy for the group 224.0.0.0/4
```

Switch S5 Configuration Commands. The following is an example configuration for switch S5, which serves as the last hop router for multicast traffic:

```
create vlan comm_vlan
configure vlan comm_vlan add port 1
configure comm_vlan ipa 10.172.168.2/24
enable ipforwarding comm_vlan
enable ipmcforwarding comm._vlan
configure pim add vlan comm_vlan sparse
configure ospf add vlan comm._vlan area 0.0.0.0

create vlan receiver_vlan
configure vlan sender_vlan add port 1
configure sender_vlan ipa 10.172.170.4/24
enable ipforwarding comm_vlan
enable ipmcforwarding comm._vlan
configure pim add vlan comm._vlan sparse
configure ospf add vlan comm_vlan area 0.0.0.0

enable pim
enable ospf

configure pim crp static 10.172.169.4 pim_policy // RP is configured using the policy
pim_policy for the group 224.0.0.0/4
```

Switch S4 Configuration Commands. The following is an example configuration for switch S4, which is neither an LHR nor a RP:

```
create vlan comm_vlan
configure vlan comm_vlan add port 1
configure comm_vlan ipa 10.172.168.3/24
enable ipforwarding comm_vlan
enable ipmcforwarding comm._vlan
```

```
configure pim add vlan comm_vlan sparse
configure ospf add vlan comm._vlan area 0.0.0.0
```

```
enable pim
enable ospf
```

```
configure pim crp static 10.172.169.4 pim_policy // RP is configured using the policy
pim_policy for the group 224.0.0.0/4
```

Switch S2 Configuration Commands. The following is an example configuration for switch S2, which is not enabled for PIM:

```
create vlan comm_vlan
configure vlan comm_vlan add port 1
configure comm_vlan ipa 10.172.168.6/24
enable ipforwarding comm_vlan
enable ipmcforwarding comm._vlan
configure ospf add vlan comm._vlan area 0.0.0.0
```

```
enable ospf
```

PIM Snooping Example Configuration Displays. After the example configuration is complete, multicast receivers connect to the network through switch S5 and multicast sources connect through switch S3.

When switch S5 receives an IGMP request from the *receiver_vlan* for group 225.1.1.1, it sends a PIM (*, G) join towards switch S3, which is the RP. The PIM snooping feature on switch S1 snoops the (*, G) join, and the resulting entry can be viewed by entering the following command at switch S1:

```
show pim snooping vlan comm_vlan
```

```
PIM Snooping                               ENABLED
Vlan comm_vlan(3971)                        Snooping ENABLED
```

Source	Group	RP	UpPort	DownPort	Age	HoldTime
*	225.1.1.1	10.172.169.4	1	2	15	210

Neighbor IP	DR	Port	Age	Hold Time
10.1272.168.4	YES	1	2	105
10.1272.168.2	NO	2	2	105
10.1272.168.3	NO	3	2	105

Once multicast traffic arrives from the *sender_vlan*, the LHR (switch S2) sends the (S, G) join message, which is snooped by the PIM snooping switch, switch S1. The resulting entries can be viewed by entering the following command at switch S1:

```
show pim snooping vlan comm_vlan
```

```
PIM Snooping                               ENABLED
Vlan comm_vlan(3971)                        Snooping ENABLED
```

Source	Group	RP	UpPort	DownPort	Age	HoldTime
*	225.1.1.1	10.172.169.4	1	2	15	210
10.172.169.10	225.1.1.1	10.172.169.4	1	2	15	210

Neighbor IP	DR	Port	Age	Hold Time
10.1272.168.4	YES	1	2	105
10.1272.168.2	NO	2	2	105
10.1272.168.3	NO	3	2	105

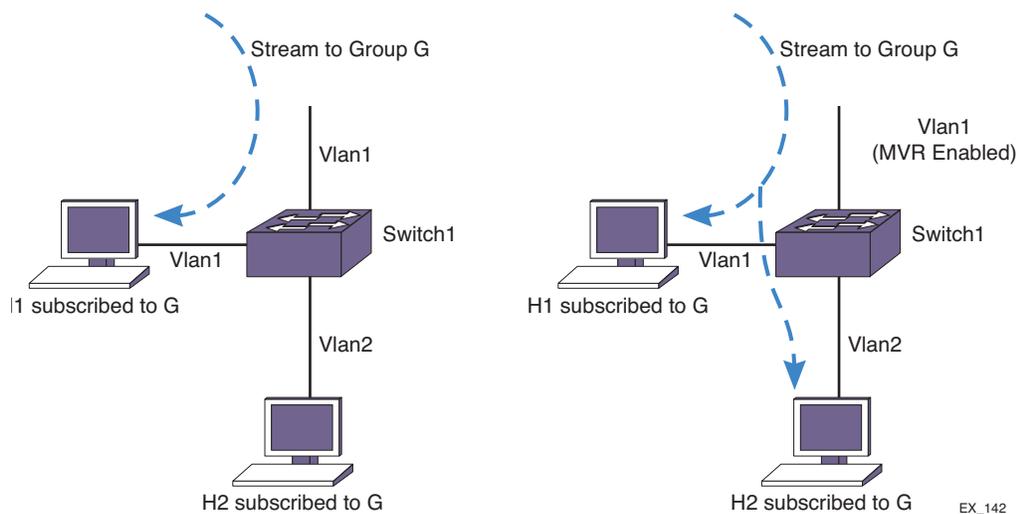
Multicast traffic is forwarded only to those ports that have received (*, G) or (S, G) joins and designated router (DR) ports.

Multicast VLAN Registration

Multicast VLAN Registration (MVR) is designed to support distributing multicast streams for IPTV to subscribers over a Layer 2 network. In a standard Layer 2 network, a multicast stream received on a VLAN is not forwarded to another VLAN. The streams are confined to the Layer 2 broadcast domain. In an IGMP snooping environment, streams are forwarded only to interested hosts on a VLAN. For inter-VLAN forwarding (routing) a multicast routing protocol, such as PIM/DVMRP must be deployed.

MVR breaks this basic rule, so that a stream received over Layer 2 VLANs is forwarded to another VLAN, eliminating the need for a Layer 3 routing protocol. It simplifies the multicast stream distribution and is a better solution for IPTV-like services. With MVR, a multicast stream is forwarded to all VLANs containing interested hosts.

Figure 229: Standard VLAN Compared to an MVR VLAN



In [Figure 229](#), the left side shows a standard VLAN carrying a multicast stream. The host H1 receives the multicast stream because it resides on VLAN Vlan1, but host H2 does not receive the multicast traffic because no IP multicast routing protocol forwards the stream to VLAN Vlan2. On the right side of the figure, H2 does receive the multicast stream. Because Vlan1 was configured as an MVR VLAN, the multicast stream is forwarded to the other VLANs on the switch, containing hosts that have requested the stream. To configure a VLAN as an MVR VLAN, use the following command:

```
configure mvr add vlan <vlan-name>
```

Typically, IGMP snooping is enabled, so only hosts that have requested a stream can see the multicast traffic. For example, another host on Vlan2 cannot receive the traffic unless it has sent an IGMP request to be included in the group.

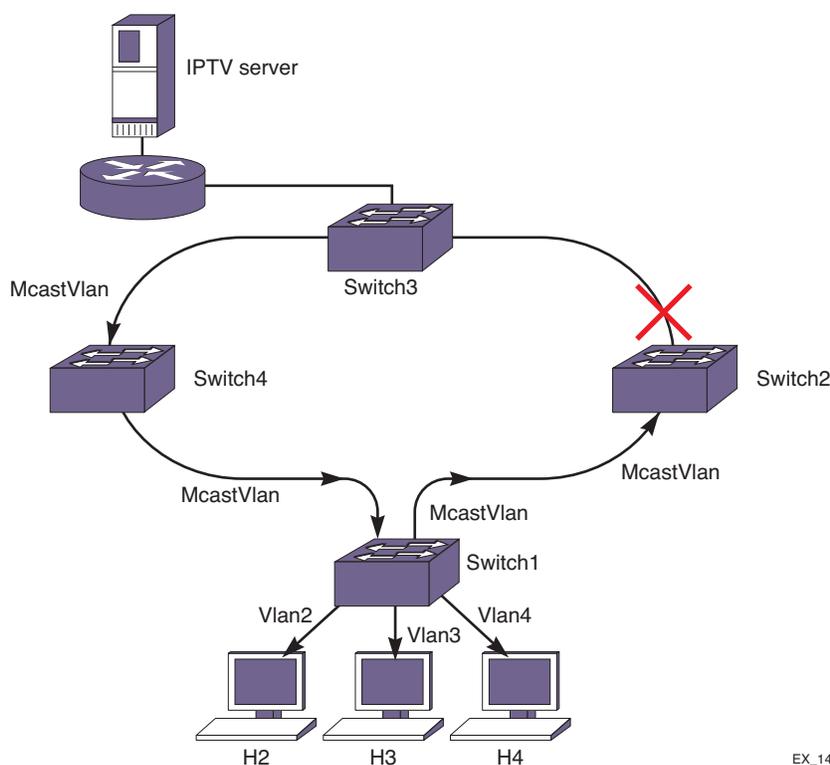
Notice that only Vlan1 is MVR enabled. Configure MVR only on the ingress VLAN. To enable MVR on the switch, use the following command:

```
enable mvr
```

Basic MVR Deployment

Since MVR is primarily targeted for IPTV and similar applications, a basic deployment for that application is shown in [Figure 230](#). In the figure, an IPTV server is connected through a router to a network of switches. Switch 1 has three customer VLANs, Vlan2, Vlan3, and Vlan4. The multicast streams are delivered through the network core (Metro Ethernet), which often use a ring topology and some kind of redundant protection to provide high availability. For example, McastVlan forms a ring through switches Switch1 through Switch4. The link from Switch2 to Switch4 is shown as blocked, as it would be if some form of protection (such as EAPS) is used.

Figure 230: Basic MVR Deployment



Without MVR, there are two ways to distribute multicast streams in this topology:

- Extend subscriber VLANs (Vlan2, Vlan3, and Vlan4) to the network core, by tagging the ports connecting the switches.
- Configure all VLANs with an IP address and run PIM or DVMRP on each switch.

There are problems with both of these approaches. In the first approach, multiple copies of the same stream (IPTV channel) would be transmitted in the core, wasting bandwidth. In the second approach, all switches in the network core would have to be Layer 3 multicast aware, and would have to run a multicast protocol. Typical network cores are Layer 2 only.

MVR provides a simple solution to this problem. If McastVlan in Switch1 is configured with MVR, it leaks the traffic into the local subscriber VLANs that contain hosts that request the traffic. For simple cases, perform these configuration steps:

- 1 Configure MVR on McastVlan.
- 2 Configure an IP address and enable IGMP and IGMP snooping on the subscriber VLANs (by default IGMP and IGMP snooping are enabled on Extreme Networks' switches).
- 3 For all the multicast streams (IPTV channels), configure static IGMP snooping membership on the router on McastVlan.
- 4 Enable MVR on the switches in the network.

**NOTE**

MVR works best with IGMPv1 and IGMPv2. Extreme Networks recommends that you do not use MVR with IGMPv3.

The strategy above conserves bandwidth in the core and does not require running PIM on the subscriber switches.

In this topology, a host (for example, a cable box or desktop PC) joins a channel through an IGMP join message. Switch1 snoops this message and adds the virtual port to the corresponding cache's egress list. This is possible because an MVR enabled VLAN can leak traffic to any other VLAN. When the user switches to another channel, the host sends an IGMP leave for the old channel and a join for the new channel. The corresponding virtual port is removed from the cache for the old channel and is added to the cache for the new channel.

As discussed in “[Static and Dynamic MVR](#),” McastVlan also proxies IGMP joins learned on other VLANs to the router. On an MVR network it is not mandatory to have a router to serve the multicast stream. All that is required is to have a designated IGMP querier on McastVlan. The IPTV server can also be directly connected to McastVlan.

Static and Dynamic MVR

This section presents the following topics:

- [Static MVR on page 1427](#)
- [Dynamic MVR on page 1428](#)
- [Configuring Static and Dynamic MVR on page 1428](#)

Static MVR. In a typical IPTV network, there are several high demand basic channels. At any instant there is at least one viewer for each of these channels (streams), and they should always be available at the core. When a user requests one of these channels, it is quickly pulled locally from the multicast VLAN. These streams are always available on the core multicast VLAN through static configuration on the streaming router. For those channels, the Layer 2 switch does not send any IGMP join messages towards the IGMP querier. These groups must be statically configured on the streaming router so that these streams are always available on the ring. For example, on an Extreme Networks router, you can use the following command:

```
configure igmp snooping {vlan} <vlanname> ports <portlist> add static router
```

If a multicast packet for a group in the static MVR range is received on an MVR enabled VLAN, it is always flooded on the MVR VLAN. This allows the neighbor switch in the ring to receive all the static MVR streams.

Dynamic MVR. In contrast, since a video content provider would like to provide a variety of on-demand and other premium channels, there are often many lower demand (fewer viewers) premium channels that cannot all be made available simultaneously at the core network. These should be streamed from the router only if requested by a host.

IGMP is the standard method used by a host to request a stream. However, IGMP packets are constrained to a VLAN. Thus, subscribers' IGMP join requests on the VLAN cannot be forwarded onto other VLANs. With MVR, a VLAN sends proxy IGMP join messages on behalf of all the subscriber VLANs on the switch. Thus, in [Figure 230](#), McastVlan sends join and leave messages on behalf of Vlan2, Vlan3, and Vlan4. The router receives the messages on McastVlan and streams corresponding channels onto the core network. This provides on-demand service, and an administrator doesn't need to configure static IGMP on the router for each of these channels.

Configuring Static and Dynamic MVR. By default, all MVR streams are static. You can specify which groups are static by using the following command:

```
configure mvr vlan <vlan-name> static group {<policy-name> | none}
```

Any other groups in the MVR address range are dynamic. You can specify the MVR address range by using the following command:

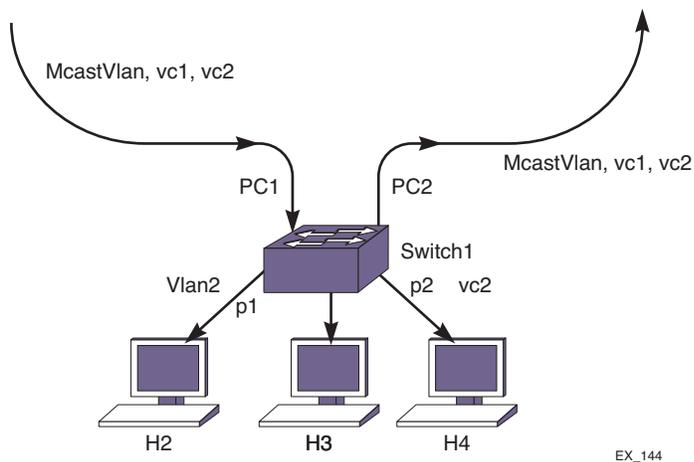
```
configure mvr vlan <vlan-name> mvr-address {<policy-name> | none}
```

By using these two commands together, you can specify which groups are static and which are dynamic. If you want all the groups to be dynamic, specify a policy file for the static group command that denies all multicast addresses.

MVR Forwarding

The goal for MVR is to limit the multicast traffic in the core Layer 2 network to only the designated multicast VLAN. If the backbone Layer 2 port is tagged with multiple VLANs, as shown in [Figure 231](#), a set of rules is needed to restrict the multicast streams to only one VLAN in the core.

Figure 231: Multiple VLANs in the Core Network



In [Figure 231](#), the core network has 2 more VLANs, vc1 and vc2, to provide other services. With MVR, multicast traffic should be confined to McastVlan, and should not be forwarded to vc1 and vc2. It should be noted that MVR is configured only on the ingress VLAN (McastVlan). MVR is not configured on any other VLANs.

In the same way as the IGMP snooping forwarding rules, the multicast stream is forwarded onto member ports and router ports on the VLAN. For a stream received on MVR enabled ports, this rule is extended to extend membership and router ports to all other VLANs. This rule works well on the topology in [Figure 230](#). However, in a tagged core topology, this rule forwards traffic onto VLANs, such as vc1 and vc2, on ports PC1 and PC2. This results in multiple copies of same stream on the core network, thus reintroducing the problem that MVR was intended to solve.

To avoid multiple copies of the same stream, MVR forwards traffic with some special restrictions. MVR traffic is not forwarded to another VLAN unless a host is detected on the port. On the ingress MVR VLAN, packets are not duplicated to ports belonging to MVR VLANs. This is to prevent duplicate multicast traffic streams on ingress ports. Streams belonging to static MVR groups are always forwarded on MVR VLANs so that any host can join such channels immediately. However, dynamic groups are streamed from the server only if some host is interested in them. A command is provided to receive traffic on a port which is excluded by MVR. However, regular IGMP rules still apply to these ports, so the ports must have a router connected or an IGMP host to receive the stream.

These rules are to prevent multicast packets from leaking into an undesired virtual port, such as p2 on VLAN pc2 in [Figure 231](#). These rules also allow that, in most topologies, MVR can be deployed with minimal configuration. However, unlike EAPS and STP, MVR is not intended to be a Layer 2 protocol to solve packet looping problems. Since multicast packets leak across VLANs, one can misconfigure and end up with a multicast storm. MVR does not attempt to solve such problems.

**NOTE**

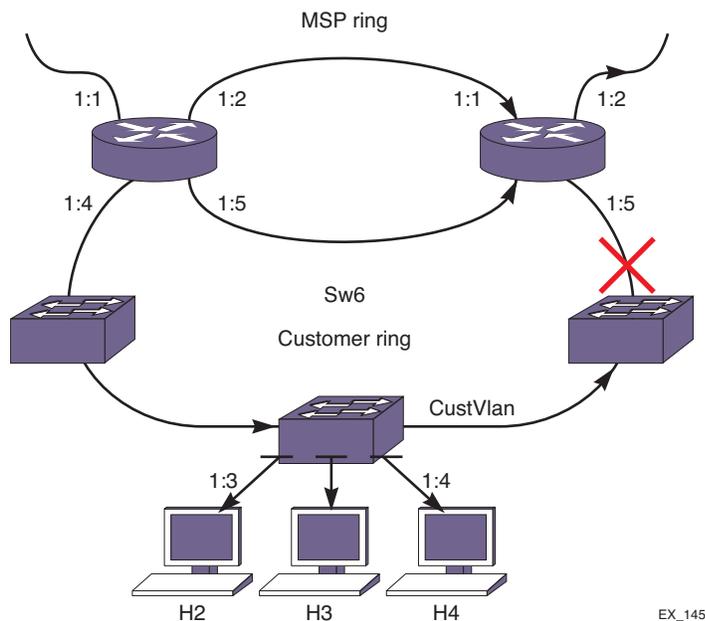
If a port is blocked by Layer 2 protocols, that port is removed from the egress list of the cache. This is done dynamically per the port state.

For most situations, you do not need to manually configure ports to receive the MVR multicast streams. But if one of the forwarding rules denies forwarding to a port that requires the streams, you can manually receive the MVR multicast streams by using the following command:

```
configure mvr vlan <vlan-name> add receiver port <port-list>
```

Inter-Multicast VLAN Forwarding

In “[Basic MVR Deployment](#)” only simple topologies are considered, in which subscribers on different VLANs access a multicast VLAN. There are topologies where streams need to be forwarded onto another multicast VLAN, as shown in [Figure 232](#). In this figure, a Multicast Service Provider (MSP) multicast VLAN is attached to ports 1:1-2 on both switches, SW1 and SW2. On the customer side, another multicast VLAN, delivers multicast streams to other switches around the ring.

Figure 232: Inter-Multicast VLAN Forwarding

In this topology, a multicast stream can be leaked into the customer multicast network through either switch SW1 or SW2. However, as described in “[MVR Forwarding](#),” packets are not forwarded to router ports (ports 1:4 and 1:5 can be router ports if SW2 is an IGMP querier). To get around this, MVR needs to be configured on CustVlan either on SW1 or SW2. Since the forwarding rules apply only to non-MVR VLANs, traffic from one MVR VLAN is leaked into the router ports of another VLAN, if MVR is enabled on that.

In the topology above, the MSP multicast VLAN is carried on two switches that also carry the customer multicast VLAN. When multiple switches carry both multicast VLANs, it is imperative that MVR is configured on only one switch. Only that switch should be used as the transit point for multicast streams from one multicast ring into another. Otherwise, duplicate packets are forwarded. Also on the non-MVR switches, the ring ports should be configured as static router ports, so that ring ports are excluded from forwarding packets onto the customer ring. There is no mechanism to elect a designated MVR forwarder, so it must be configured correctly.

MVR Configurations

MVR enables Layer 2 network installations to deliver bandwidth intensive multicast streams. It is primarily aimed at delivering IPTV over Layer 2 networks, but it is valuable in many existing EAPS or STP installations. This section explores a few possible deployment scenarios and configuration details. Of course, real world networks can be lot different from these examples. This section is meant to present some ideas on how to deploy MVR over existing networks, as well as to design new networks that support MVR.

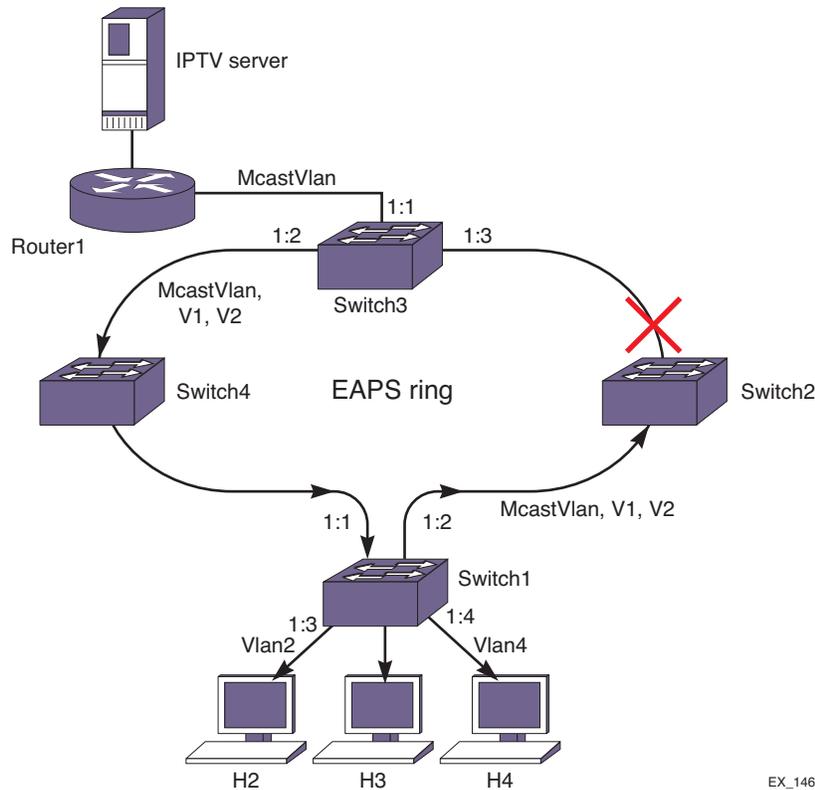
MVR with EAPS

Since MVR is designed with a Layer 2 ring topology in mind, it is strongly recommended that it should be deployed with EAPS. The MVR plus EAPS combination provides a superior solution for any triple play network, where the service provider intends to provide data, voice, and video services. EAPS is a

proven solution for providing sub-second SONET-like protection to Layer 2 rings. For more detail on EAPS refer to [Chapter 25, “EAPS.”](#)

Consider a typical EAPS topology in [Figure 233](#), where 3 VLANs on the core ring serve various clients on each switch. To provide video service, one of the VLANs on the EAPS ring is designated as a multicast VLAN. MVR is enabled only on this VLAN (mcastvlan). V1 is the control VLAN, and V2 is another protected VLAN. A router serving the multicast feed would typically run PIM on mcastvlan, to support the static and dynamic IGMP membership on the VLAN.

Figure 233: MVR on an EAPS Ring



EX_146

The following is a typical configuration for the router and switches.

Router1:

```
create vlan mcastvlan
configure mcastvlan add port 1:1
create vlan server
configure server add port 1:2
configure mcastvlan ipaddress 10.1.1.1/24
configure server ipaddress 11.1.1.1/24
configure igmp snooping mcastvlan port 1:1 add static group 239.1.1.1
enable ipforwarding
enable ipmcforwarding
configure igmp snooping leave-timeout 2000
configure pim add vlan all
enable pim
```

Switch1:

```
create vlan mcastvlan
create vlan v1
create vlan v2
create vlan vlan2
configure vlan vlan2 add port 1:3
configure vlan vlan2 ipaddress 10.20.1.1/24
configure mcastvlan tag 20
configure mcastvlan add port 1:1,1:2 tag
configure mvr add vlan mcastvlan
configure vlan v1 tag 30
configure v1 add port 1:1,1:2 tag
configure vlan v2 tag 40
configure v2 add port 1:1,1:2 tag

create eaps e1
configure eaps e1 mode transit
configure eaps e1 add control vlan v1
configure eaps e1 add protect vlan mcastvlan
configure eaps e1 add protect vlan v2
configure eaps port primary port 1:1
configure eaps port secondary port 1:2
enable eaps
enable mvr
```

Switch3:

```
create vlan McastVlan
create vlan v1
create vlan v2
configure mcastvlan tag 20
configure mcastvlan add port 1:2,1:3 tag
configure mcastvlan add port 1:1
configure mvr add vlan mcastvlan
configure vlan v1 tag 30
configure v1 add port 1:2,1:3 tag
configure vlan v2 tag 40
configure v2 add port 1:2,1:3 tag

create eaps e1
configure eaps e1 mode master
configure eaps e1 add control vlan v1
configure eaps e1 add protect vlan mcastvlan
configure eaps e1 add protect vlan v2
configure eaps port primary port 1:3
configure eaps port secondary port 1:2
enable eaps
enable mvr
```



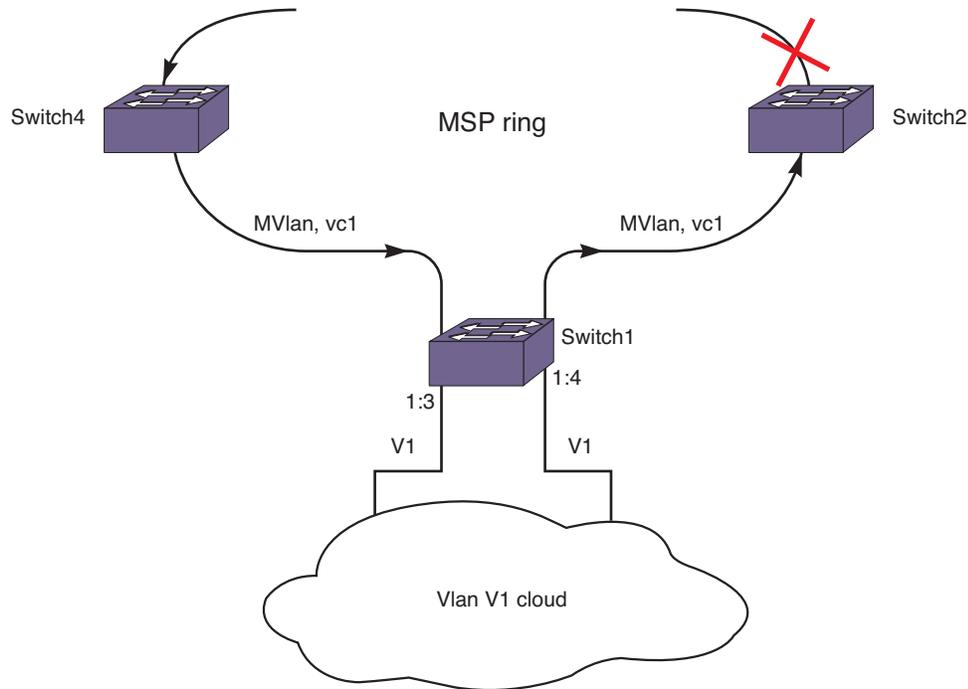
NOTE

In this example, Switch3 is the EAPS master, but any of the other switches in the ring could have been configured as the master.

MVR with STP

In a Layer 2 ring topology, MVR works with STP as it works with EAPS. However, in other Layer 2 topologies, additional configuration steps may be needed to make sure that multicast feeds reach all network segments. Extra configuration is required because all ports in the VLAN are part of an STP domain, so that solely by examining the configuration it is not clear whether a port is part of bigger ring or is just serving a few hosts. In EAPS this problem is solved by distinguishing between configured primary or secondary ports from other VLAN ports. Consider a simplified Layer 2 STP network as shown in [Figure 234](#).

Figure 234: MVR with STP



EX_148

In this topology, subscribers are in a Layer 2 cloud on VLAN V1. STP is configured for all ports of V1. Since V1 spans on the ring as well, multicast cannot be forwarded on V1 blindly. Forwarding rules (described in [“MVR Forwarding”](#)), dictate that multicast traffic is not forwarded on STP enabled ports. This is to make sure that multiple copies of multicast packets are not forwarded on the ring. However, since other STP enabled ports on V1 (1:3,1:4) are not part of the ring multicast stream, they need to be configured so that they get the packets. To configure the ports to receive packets, use the following command (mentioned previously in [“MVR Forwarding”](#)):

```
configure mvr vlan <vlan-name> add receiver port <port-list>
```



NOTE

If the Layer 2 cloud is connected back to ring ports, traffic may end up leaking into VLAN V1 in the ring. There is no way to avoid that. So, such topologies must be avoided.

The following is a typical configuration for Switch 1 in [Figure 234](#):

```
create vlan v1
configure v1 tag 200
configure v1 add port 1:1, 1:2 tag
configure v1 add port 1:3, 1:4
create vlan mvlan
configure mvlan add port 1:1, 1:2
configure mvr add vlan mvlan
create stpd stp1
configure stp1 add vlan v1 port all
enable stpd stp1 port all
configure mvr vlan v1 add receiver port 1:3,1:4
enable mvr
```

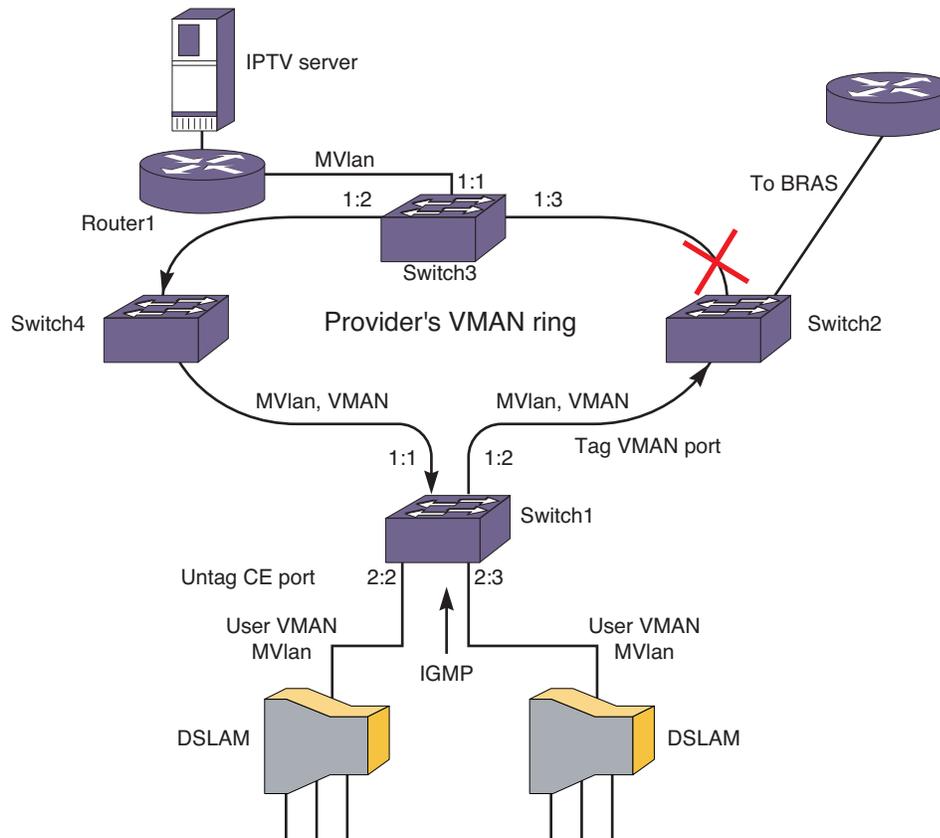
MVR in a VMAN Environment

In the case of a VMAN, a packet is tagged with a VMAN tag in addition to a possible VLAN tag. This is to provide VLAN aggregation for all customer traffic in the VMAN ring. Each customer is given its own VLAN, and traffic from all customers can be tunneled on a single VMAN tag into the metro ring to an outside Broadband Remote Access Server (BRAS). In a VMAN network, multicast traffic can be distributed over a separate VLAN in the metro core. These packets are not subjected to VMAN tunneling. Thus, IPTV service can be provided on this multicast VLAN on a VMAN network.

MVR deployment in a VMAN environment is not any different from that in an EAPS environment, since a separate multicast VLAN on the metro ring is used for multicasting. However, it provides interesting capabilities to MSPs for their video offerings. Different service bundles can be offered on separate VLANs. Packets are not forwarded to any metro link segments where a stream is not required.

[Figure 235](#) illustrates an example design for MVR in a VMAN environment. Any multicast packet entering on MVlan is forwarded on MVlan to the next switch. These multicast packets are not tunneled.

With MVR, switches on the VMAN do not have to run any routing protocol. If MVR is enabled on the multicast VLAN, MVlan, traffic is pulled from the IPTV server. Such multicast packets egressing from the CE port are always untagged. The downstream DSLAM distributes untagged multicast packets to the respective subscriber VLANs.

Figure 235: MVR in a VMAN Environment

EX_149

The following is a typical configuration for Switch 1 in [Figure 235](#):

```

create vman vman2
configure vman vman2 tag 300
configure vman vman2 add port 2:2-2:3 untagged
configure vman vman2 add port 1:1,1:2 tagged
enable port 2:*
enable port 1:*
create vlan mvlan
configure vlan mvlan tag 200
configure vlan mvlan add port 1:1,1:2 tag
configure mvr add vlan mvlan
enable mvr

```

Displaying Multicast Information

The following sections describe how to display multicast information:

- [Displaying the Multicast Routing Table on page 1436](#)
- [Displaying the Multicast Cache on page 1436](#)
- [Looking Up a Multicast Route on page 1436](#)
- [Looking Up the RPF for a Multicast Source on page 1436](#)
- [Displaying the PIM Snooping Configuration on page 1436](#)

Displaying the Multicast Routing Table

To display part or all of the entries in the multicast routing table, use the following command:

```
show iproute {ipv4} {{vlan} <name> | [<ipaddress> <netmask> | <ipNetmask>] | origin
[direct | static | mbgp | imbgp | embgp]} multicast {vr <vr_name>}
```

Displaying the Multicast Cache

The multicast cache stores information about multicast groups. To display part or all of the entries in the multicast cache, use the following command:

```
show mcast cache {{vlan} <name>} {[group <grpaddressMask> | <grpaddressMask>] {source
<sourceIP> | <sourceIP>}} {type [snooping | pim | mvr]}| {summary}}
```

Looking Up a Multicast Route

To look up the multicast route to a specific destination, use the following command with the `multicast` option:

```
rtlookup [<ipaddress> | <ipv6address>] { unicast | multicast | rpf } { vr <vr_name> }
```

Looking Up the RPF for a Multicast Source

To look up the RPF for a multicast source, use the following command with the `rpf` option:

```
rtlookup [<ipaddress> | <ipv6address>] { unicast | multicast | rpf } { vr <vr_name> }
```

Displaying the PIM Snooping Configuration

To display the PIM snooping configuration for a VLAN, use the following command:

```
show pim snooping {vlan} <name>
```

Troubleshooting PIM

The following sections introduce two commands that you can use to troubleshoot multicast communications:

- [Multicast Trace Tool on page 1437](#)
- [Multicast Router Information Tool on page 1438](#)

Multicast Trace Tool

The multicast trace tool is the multicast equivalent of unicast *trace route* mechanism and is an effective tool for debugging multicast reachability problems. This tool is based on an IETF draft and uses IGMP. Because it is harder to trace a multicast path from the source to the destination, a multicast trace is run from the destination to the source. The multicast trace can be used to do the following:

- Locate where a multicast traffic flow stops
- Identify sub-optimal multicast paths

A multicast trace is used for tracing both potential and actual multicast forwarding tree paths. When the multicast tree is established and traffic is flowing, this tool traces the actual traffic flow. If there is no traffic while executing the command, this tool displays the potential path for the group and source being traced.

You can direct a multicast trace to any network destination, which can be a multicast source or destination, or a node located between a source and destination. After you initiate the trace, a multicast trace query packet is sent to the last-hop multicast router for the specified destination. The query packet contains the source address, group address, destination/receiver address, response address, maximum number of hops, and TTL to be used for the multicast trace response.

The previous hop router selection is based on the multicast routing protocol and the state for the S,G entry in the processing router. For example:

- If there is no S,G state in the router, the parent closest to the RP is chosen as the previous hop.
- If the S,G state exists in the router, the parent closest to the source is chosen as the previous hop.

The last hop router converts the multicast trace query into a unicast traceroute *request* by appending response data (for the last hop router) into the received query packet, and the last hop router forwards the request packet to the router that it believes is the proper previous hop for the given source and group. Each multicast router adds its response data to the end of the request packet, and then forwards the modified unicast request to the previous hop.

The first hop router (the router that determines that packets from the source originate on one of its directly connected networks) changes the packet type to *response packet* and sends the completed response to the query generator. If a router along the multicast route is unable to determine the forwarding state for a multicast group, that router sends a response back to the originator with *NO ROUTE* forwarding code.

To initiate a multicast trace, use the following command:

```
mtrace source <src_address> {destination <dest_address>} {group <grp_address>} {from
<from_address>} {gateway <gw_address>} {timeout <seconds>} {maximum-hops <number>}
{router-alert [include | exclude]} {vr <vrname>}
```

Multicast Router Information Tool

The multicast router information tool is an ExtremeXOS command that allows you to request information from a specific multicast router. For more information, see the command description for the following command:

```
mrinfo {<router_address>} {from <from_address>} {timeout <seconds>} {multiple-  
response-timeout <multi_resp_timeout>} {vr <vrname>}
```

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CHAPTER

IPv6 Multicast

This chapter includes the following sections:

- [Overview on page 1439](#)
- [Managing MLD on page 1440](#)

For more information on IPv6 multicasting, refer to the following publications:

- RFC 2710—*Multicast Listener Discovery (MLD) for IPv6*
- RFC 3810—*Multicast Listener Discovery Version 2 (MLDv2) for IPv6*

Overview

IPv6 multicast is a function that allows a single IPv6 host to send a packet to a group of IPv6 hosts.

Multicast Listener Discovery (MLD) is a protocol used by an IPv6 host to register its IP multicast group membership with a router. To receive multicast traffic, a host must explicitly join a multicast group by sending an MLD report; then, the traffic is forwarded to that host. Periodically, the router queries the multicast group to see if the group is still in use. If the group is still active, a single IP host responds to the query, and group registration is maintained.

MLD is the IPv6 equivalent to IGMP, and MLDv1 is equivalent to IGMPv2. The ExtremeXOS software supports both MLDv1 and MLDv2 protocol.



NOTE

This release does not support MVR, PVLAN, VLAN Aggregation, and Multicast Troubleshooting tools for MLD/IPv6.



NOTE

This release supports host registration through MLD, but it does not support IPv6 multicast routing. If the switch is connected to an IPv6 multicast router, it can register for IPv6 multicast groups and forward IPv6 multicast traffic.

Managing MLD

The following sections describe how to manage MLD on the switch:

- [Enabling and Disabling MLD on a VLAN on page 1440](#)
- [Configuring MLD on page 1440](#)
- [Clearing MLD Group Registration on page 1440](#)
- [Configuring Static MLD Groups and Routers on page 1440](#)
- [Displaying MLD Information on page 1441](#)

Enabling and Disabling MLD on a VLAN

MLD is disabled by default on all VLANs. You can enable MLD using the `enable mld {vlan <vlan name>} {MLDv1 | MLDv2}` command.

This allows IPv6 hosts to register with IPv6 multicast groups and receive IPv6 multicast traffic. To disable MLD on a VLAN after it has been enabled, use the `disable mld {vlan <name>}` command.

To enable MLD on a VLAN after it has been disabled, use the `enable mld {vlan <vlan name>} {MLDv1 | MLDv2}` command.

Configuring MLD

To configure the timers that control MLD operation, use the `configure mld <query_interval> <query_response_interval> <last_member_query_interval> {<robustness>}` command.

Clearing MLD Group Registration

To clear a single group or all groups in a VLAN learned through MLD, use the following command:

```
clear mld group {<v6grpipaddress>} {{vlan} <name>}
```

Configuring Static MLD Groups and Routers

In some situations, you might want multicast traffic to be forwarded to a port where a multicast-enabled host is not available (for example, when you test multicast configurations).

Static MLD emulates a host or router attached to a switch port, so that multicast traffic is forwarded to that port, and the switch sends a proxy join for all the statically configured MLD groups when an MLD query is received. You can emulate a host to forward a particular multicast group to a port; and you may emulate a router to forward all multicast groups to a port.

To emulate a host on a port, use the following command:

```
configure mld snooping {vlan} <vlaname> ports <portlist> add static group <v6grpipaddress>
```

To emulate a multicast router on a port, use the following command:

```
configure mld snooping {vlan} <vlaname> ports <portlist> add static router
```

To remove these entries, use the corresponding command:

```
configure mld snooping {vlan} <vlanname> ports <portlist> delete static group [all | <v6grpaddress>]
```

```
configure mld snooping {vlan} <vlanname> ports <portlist> add static router
```

Displaying MLD Information

To display MLD configuration and operation information, use the following command:

```
show mld group {{vlan} {<name>} | {<v6grpaddress>}} {MLDv2}
```

To display the MLD static group information, use the following command:

```
show mld snooping vlan <name> static [group | router]
```

MLD Snooping

Similar to IGMP snooping, MLD snooping is a Layer 2 function of the switch; it does not require multicast routing to be enabled. In MLD snooping, the Layer 2 switch keeps track of MLD reports and only forwards multicast traffic to the part of the local network that requires it. MLD snooping optimizes the use of network bandwidth and prevents multicast traffic from being flooded to parts of the local network that do not need it.

MLD snooping is disabled by default on all VLANs in the switch. When MLD snooping is disabled on a VLAN, all MLD and IPv6 multicast traffic floods within the VLAN.

MLD snooping expects at least one device on every VLAN to periodically generate MLD query messages.

To enable or disable MLD snooping, use the following commands:

```
enable mld snooping
```

```
disable mld snooping
```

Multicast packets with a scope id less than 2 are not forwarded by the MLD snooping enabled switch. Kill entry is installed in the hardware for this traffic.

Multicast packets with a scope id of 2 and group address in the range of FF02::/111 (Addresses allocated by IANA as per RFC 3307) are always flooded to all ports of the VLAN by hardware and a copy of the packet is provided to slow path. There are no cache entries in software or hardware for these addresses.

Multicast packets with a scope id of 2 and group address as solicited multicast address (FF02::1:FFXX:XXXX/104) are flooded to all ports of VLAN for 135 seconds (Default MLD query interval + Maximum response time), if there are no members for this group. Otherwise, the traffic is forwarded based on the snooping database. Multicast cache entries for these addresses are maintained only in the software and traffic is always slow path forwarded.

Multicast addresses with a scope id of 2 and that do not qualify in the above categories will be forwarded based on the snooping database. Cache entries for these multicast addresses will be installed in hardware. Unregistered packets are dropped.

In general, all multicast data traffic on a PIMv6 enabled VLAN is controlled by the PIMv6 protocol. However, multicast traffic with either the group address or source address as the link local address will not be controlled by PIMv6. Instead it will be L2 forwarded based on the snooping database.

For multicast packets with a scope id greater than 2 on PIMv6 enabled VLANs, cache entries are controlled by the PIMv6 protocol. PIMv6 provides a list of egress VLANs for which packets need to be forwarded. The snooping database is used to construct the set of ports for ingress VLANs as well as for each egress VLAN.

On PIMv6 disabled VLANs, traffic is forwarded based on the snooping database on the ingress VLAN. In both cases, cache entry is installed in the hardware and traffic is fast path forwarded.

When a port sends a MLD leave message, the switch removes the MLD snooping entry after 1000 milliseconds (the leave time is configurable, ranging from 0 to 175000 ms). The switch sends a query to determine which ports want to remain in the multicast group. If other members of the VLAN want to remain in the multicast group, the switch ignores the leave message, but the port that requests removal is removed from the MLD snooping table.

If the last port within a VLAN sends a MLD leave message and the switch does not receive any responses to the subsequent query, then the switch immediately removes the VLAN from the multicast group.

MLD snooping is implemented primarily through ACLs, which are processed on the interfaces. These special purpose ACLs are called MLD snooping filters. On Summit family switches and BlackDiamond 8800 series switches, the software allows you to choose between two types of MLD snooping filters: per-port filters (the default) and per-VLAN filters.

The two types of MLD snooping filters use switch hardware resources in different ways. The two primary hardware resources to consider when selecting the MLD snooping filters are the Layer 3 multicast forwarding table and the interface ACLs. The size of both of these hardware resources is determined by the switch model. In general, the per-port filters consume more resources from the multicast table and less resource from the ACL table. The per-VLAN filters consume less space from the multicast table and more from the ACL table.

In Summit family switches and BlackDiamond 8800 series switches, since the multicast table size is smaller, using the per-port filters can fill up the multicast table and place an extra load on the CPU. To avoid this, configure the switch to use the per-VLAN filters.



NOTE

The impact of the per-VLAN filters on the ACL table increases with the number of VLANs configured on the switch. If you have a large number of configured VLANs, we suggest that you use the per-port filters.

MLD Snooping Filters

MLD snooping filters allow you to configure a policy file on a port to allow or deny MLD report and leave packets coming into the port. (For details on creating policy files, see [Chapter 17, “Policy Manager”](#).) The MLD snooping filter feature is supported by MLDv1 and MLDv2.

For the policies used as MLD snooping filters, all the entries should be IPv6 address type entries, and the IPv6 address of each entry must not be in the range of FF02::/96.

Use the following template to create a snooping filter policy file that denies MLD report and leave packets for the FF03::1/128 and FF05::1/112 multicast groups:

```
#
# Add your group addresses between "Start" and "end"
# Do not touch the rest of the file!!!!
entry mldFilter {
```

```

if match any {
#----- Start of group addresses -----
nlri FF03::1/128;
nlri FF05::1/112;
#----- end of group addresses -----
} then {
deny;
}
}

```

```

entry catch_all {
if {

} then {
permit;
}
}

```

After you create a policy file, use the following command to associate the policy file and filter to a set of ports:

```
configure mld snooping vlan ports filter
```

To remove the filter, use the none option.

To display the MLD snooping filters, use the following command:

```
show mld snooping {vlan} <name> filter
```

Limiting the Number of Multicast Sessions on a Port

The default configuration places no limit on the number of multicast sessions on each VLAN port. To place a limit on the number of sessions, or to remove the limit, use the following command:

```
configure mld snooping {vlan} <vlannname> ports <portlist> join-limit [<num_joins> | no-limit]
```


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CHAPTER

MSDP

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NOTE

For more information about MSDP, refer to RFC 3618.

Overview

Multicast Source Discovery Protocol (MSDP) is an interdomain multicast protocol used to connect multiple multicast routing domains that run Protocol Independent Multicast-Sparse Mode (PIM-SM). MSDP speakers are configured on each PIM-SM domain. These speakers establish a peering relationship with other MSDP speakers through secured TCP connections. When the source sends traffic, the MSDP speaker learns about the source through its Rendezvous Point (RP). In turn, the RP advertises the source to its peers through Source Active (SA) messages. The peers receive these advertisements and inform their RPs about the presence of the active source in the other PIM-SM domain, which triggers the normal PIM operation in the corresponding domains.

For example, as businesses expand and networks grow in size, it might become necessary to connect PIM domains to allow multicast applications to reach other offices across the network. MSDP simplifies this process by providing a mechanism to connect those multicast routing domains without reconfiguring existing domains. Each PIM domain remains separate and has its own RP. The RP in each domain establishes an MSDP peering relationship over a TCP connection either with RPs in other

domains or with border routers leading to other domains. When an RP learns about a new multicast source in its own domain (using the normal PIM registration process), it then sends a SA message to all of its MSDP peers, letting them know about the new stream. In this way, the network can receive multicast traffic from all over the network without having to reconfigure each existing PIM domain.

Supported Platforms

MSDP is supported on all platforms running a minimum software version of ExtremeXOS 12.0 with the Core license.

Our implementation of MSDP is compliant with RFC 3618 and RFC 3446, and compatible with other devices that are compliant with these standards.

Limitations

The limitations of MSDP are as follows:

- There is no support for MSDP operating with SA cache disabled (transit node). MSDP will always cache/store received SA messages.
- There is no support for logical RP.
- There is no support for MSDP on user-created virtual routers (VRs).
- RIP routes are not used for peer-RPF checking. So, our implementation of MSDP does not exactly conform to rule (iii) in section 10.1.3 of RFC 3618. However, our implementation of MSDP uses BGP/OSPF for peer-RPF checking as per rule (iii) in section 10.1.3.
- Read-write/read-create access is not supported on MSDP MIB objects.

PIM Border Configuration

To create a PIM-SM domain for MSDP, you must restrict the reach of Bootstrap Router (BSR) advertisements by defining a VLAN border. BSR advertisements are not sent out of a PIM interface configured as a VLAN border, thereby defining a PIM domain for MSDP.

To configure a PIM VLAN border, use the following command:

```
configure pim <vlan_name> border
```

MSDP Peers

MSDP peers exchange messages to advertise active multicast sources. The peer with the higher IP address passively listens to a well-known port number and waits for the side with the lower IP address to establish a Transmission Control Protocol (TCP) connection on port 639. When a PIM-SM RP that is running MSDP becomes aware of a new local source, it sends an SA message over the TCP connection to its MSDP peer. When the SA message is received, a peer-RPF check is performed to make sure the peer is toward the originating RP. If so, the RPF peer floods the message further. If not, the SA message is dropped and the message is rejected.

To configure an MSDP peer, use the following command:

```
create msdp peer <remoteaddr> {remote-as <remote-AS>} {vr <vrname>}
```

To delete an MSDP peer, use the following command:

```
delete msdp peer [all | <remoteaddr>] {vr <vrname>}
```

To display configuration and run-time parameters about an MSDP peer, use the following command:

```
show msdp [peer {detail} | {peer} <remoteaddr>] {vr <vrname>}
```

MSDP Default Peers

You can configure a default peer to accept all SA messages. Configuring a default peer simplifies the peer-RPF checking of SA messages. If no policy is specified, the current peer is the default RPF peer for all SA messages.

When configuring a default peer, you can also specify an optional policy filter. If the peer-RPF check fails, and a policy filter is configured, the default peer rule is applied to see if the SA message should be accepted or rejected.

You can configure multiple default peers with different policies. However, all default peers must either be configured with a default policy or not. A mix of default peers, with a policy and without a policy, is not allowed.

To configure an MSDP default peer, and optional policy filter, use the following command:

```
configure msdp peer [<remoteaddr> | all] default-peer {default-peer-policy <filter-name>} {vr <vrname>}
```

To remove the default peer, use the following command:

```
configure msdp peer [<remoteaddr> | all] no-default-peer {vr <vrname>}
```

To verify that a default peer is configured, use the following command:

```
show msdp [peer {detail} | {peer} <remoteaddr>] {vr <vrname>}
```

Peer Authentication

MSDP supports TCP MD5 authentication (RFC 2385) to secure control messages between MSDP peers. You must configure a secret password for an MSDP peer session to enable TCP MD5 authentication. When a password is configured, MSDP receives only authenticated MSDP messages from its peers. All MSDP messages that fail TCP MD5 authentication are dropped.

To configure TCP MD5 authentication on an MSDP peer, use the following command:

```
configure msdp peer [<remoteaddr> | all] password [none | {encrypted} <tcpPassword>] {vr <vrname>}
```

To remove the password, use the following command:

```
configure msdp peer {all | <remoteaddr>} password none
```

The password displays in encrypted format and cannot be seen as simple text. Additionally, the password is saved in encrypted format.

To display the password in encrypted format, use the following command:

```
show msdp [peer {detail} | {peer} <remoteaddr>] {vr <vrname>}
```

Policy Filters

You can configure a policy filter to control the flow of SA messages going to or coming from an MSDP peer. For example, policy filters can help mitigate state explosion during denial of service (DoS) or other attacks by limiting what is propagated to other domains using MSDP.

To configure an incoming or outgoing policy filter for SA messages, use the following command:

```
configure msdp peer [<remoteaddr> | all] sa-filter [in | out] [<filter-name> | none] {vr <vrname>}
```

To remove a policy filter for SA messages, use the `none` keyword:

```
configure msdp [{peer} <remoteaddr> | peer all] sa-filter [in | out] none
```

To verify that a policy filter is configured on an MSDP peer, use the following command:

```
show msdp [peer {detail} | {peer} <remoteaddr>] {vr <vrname>}
```

SA Request Processing

You can configure the router to accept or reject SA request messages from a specified MSDP peer or all peers. If an SA request filter is specified, only SA request messages from those groups permitted are accepted. All others are ignored.

To configure the router to accept SA request messages from a specified MSDP peer or all peers, use the following command:

```
enable msdp [{peer} <remoteaddr> | peer all] process-sa-request {sa-request-filter <filter-name> } {vr <vrname>}
```

To configure the router to reject SA request messages from a specified MSDP peer or all peers, use the following command:

```
disable msdp [{peer} <remoteaddr> | peer all] process-sa-request {vr <vrname>}
```

To display configuration and run-time parameters about MSDP peers, use the following command:

```
show msdp [peer {detail} | {peer} <remoteaddr>] {vr <vrname>}
```

MSDP Mesh-Groups

MSDP can operate in a mesh-group topology. A mesh-group limits the flooding of SA messages to neighboring peers. In a mesh-group, every MSDP peer must be connected to every other peer in the group. In this fully-meshed topology, when an SA message is received from a member of the mesh-group, the SA message is always accepted, but not flooded to other members of the same group. Because MSDP peers are connected to every other peer in the mesh-group, an MSDP peer is not required to forward SA messages to other members of the same mesh-group. However, SA messages are flooded to members of other mesh-groups. An MSDP mesh-group is an easy way to implement inter-domain multicast, as it relaxes the requirement to validate looping of MSDP control traffic (that is, peer-RPF checking is not required). Consequently, SA messages do not loop in the network.

**NOTE**

Extreme Networks recommends that you configure anycast RP peers in a mesh topology.

To configure an MSDP mesh-group, use the following command:

```
create msdp mesh-group <mesh-group-name> {vr <vrname>}
```

To remove an MSDP mesh-group, use the following command:

```
delete msdp mesh-group <mesh-group-name> {vr <vrname>}
```

To display information about an MSDP mesh-group, use the following command:

```
show msdp [mesh-group {detail} | {mesh-group} <mesh-group-name>] {vr <vrname>}
```

To configure a peer to be a member of an MSDP mesh-group, use the following command:

```
configure msdp peer [<remoteaddr> | all] mesh-group [<mesh-group-name> | none] {vr <vrname>}
```

To remove a peer from an MSDP mesh-group, use the following command:

```
configure msdp [{peer} <remoteaddr> | peer all] mesh-group none {vr <vrname>}
```

Anycast RP

Anycast RP is an application of MSDP that allows multiple RPs to operate simultaneously in a PIM-SM domain. Without anycast RP, multiple routers can be configured as candidate RPs, but at any point in time, only one router can serve as RP. Because anycast RP allows multiple RPs to be simultaneously active, anycast RP provides both load sharing and redundancy, as each RP serves the receivers that are closest to it in the network and can take over for additional receivers if another RP fails.

In an anycast RP topology, all RPs in a PIM-SM domain are configured with the same IP address on a loopback VLAN. The loopback VLAN IP address should have a 32-bit mask, so that it specifies a host address. All the routers within the PIM-SM domain select the nearest RP for each source and receiver. If the senders and receivers within the PIM-SM domain are distributed evenly, the number of senders that register with each RP is approximately equal.

Another requirement of the anycast RP topology is that MSDP must run on all RPs in the PIM-SM domain, so all RPs are also MSDP peers. Extreme Networks recommends that you configure an MSDP mesh connection between all MSDP peers in the domain.

Whenever any multicast source becomes active, this information is sent in an MSDP SA message to the other MSDP peers in the domain, announcing the presence of the source. If any RP within the domain fails, the IP routing protocol mechanism ensures that next available RP is chosen. If a sender registers with one RP and a receiver joins another RP, the information shared through MSDP enables PIM-SM to establish an SPT between the receiver and the source.

**NOTE**

Extreme Networks recommends that you configure anycast RP peers in a mesh topology.

The exchange of information in an anycast RP process works as follows:

- When the first-hop router sends a PIM Register message to the nearest RP, the PIM router checks to see if the nearest RP is the RP for the group.
- If the nearest RP is the RP for the group, an MSDP SA message is created and forwarded to the other MSDP peers.
- The MSDP SA message includes the configured originator ID, which is a mandatory configuration component.
- Each remote peer checks the RPF of the originator ID address and informs the PIM process on that remote router about active multicast sources.
- Remote receivers get data packets through the remote shared tree, and can then switch over to the SPT by sending join messages directly towards the source.

To configure anycast RP, do the following at each anycast RP router:

- 1 Create and configure a loopback VLAN using the following commands:

```
create vlan <vlan_name> {description <vlan-description>} {vr <name>}
enable loopback-mode vlan <vlan_name>
```

- 2 Assign the anycast RP address to the loopback VLAN with a 32 bit subnet mask using the following command:

```
configure {vlan} <vlan_name> ipaddress [<ipaddress> {<ipNetmask>} | ipv6-link-local |
{eui64} <ipv6_address_mask>]
```



NOTE

The anycast RP address must be unique to the loopback VLAN and be the same on all anycast RP peers. It must not match the router IP address, the PIM BSR address, or any other IP addresses used by the router or any other network devices.

- 3 Enable IP forwarding and IP multicast forwarding on the loopback VLAN using the following commands:

```
enable ipforwarding {ipv4 | broadcast} {vlan <vlan_name>}
enable ipmcforwarding {vlan <name>}
```

- 4 Add the loopback VLAN into the unicast routing domain using the appropriate command for your unicast routing protocol:

```
configure ospf add vlan <vlan-name> area <area-identifier> link-type [auto | broadcast
| point-to-point] {passive}
configure rip add vlan [<vlan-name> | all]
configure isis add [vlan all | {vlan} <vlan_name>] area <area_name> {ipv4 | ipv6}
```

- 5 Add the loopback VLAN into the PIM-SM domain and configure it as an RP using the following commands:

```
configure pim add vlan [<vlan-name> | all] {dense | sparse} {passive}
configure pim crp static <ip_address> [none | <policy>] {<priority> [0-254]}
```

- 6 Enable MSDP and establish a peering relationship with similar anycast RP neighbors using the following commands:

```
create msdp peer <remoteaddr> {remote-as <remote-AS>} {vr <vrname>}
configure msdp peer [<remoteaddr> | all] password [none | {encrypted} <tcpPassword>]
{vr <vrname>}
configure msdp peer <remoteaddr> description {<peer-description>} {vr <vrname>}
enable msdp [{peer} <remoteaddr> | peer all] {vr <vrname>}
enable msdp {vr <vrname>}
```

7 Configure a unique originator ID for each anycast RP peer using the following command:

```
configure msdp originator-id <ip-address> {vr <vrname>}
```

SA Cache

As an MSDP router learns of new sources either through a PIM-SM Source-Register (SR) message or SA message from its RPF peer, it creates an entry in SA cache (or refreshes the entry if it is already there) and forwards this information to its peers. These entries are refreshed by periodic SA messages received from the MSDP peers. If these entries are not refreshed within six minutes, they will time out. When a PIM-SM RP detects that the source is no longer available it informs MSDP, which in turn removes the SA information from the local database.

Caching makes it easy for local receivers to know immediately about inter-domain multicast sources and to initiate building a source tree towards the source. However, maintaining a cache is heavy both in CPU processing and memory requirements.



NOTE

Our implementation of MSDP does not support operating with local cache disabled.

To remove an SA cache server, use the following command:

```
unconfigure msdp sa-cache-server {vr <vrname>}
```

As MSDP uses the flood-and-join model to propagate information about sources, there is a restriction that no more than two advertisements per cache entry will be forwarded per advertisement interval. This is helpful in reducing an SA message storm and unnecessarily forwarding them to peers.

By default, the router does not send SA request messages to its MSDP peers when a new member joins a group and wants to receive multicast traffic. The new member simply waits to receive SA messages, which eventually arrive.

To configure the MSDP router to send SA request messages immediately to the MSDP peer when a new member becomes active in a group, use the following command:

```
configure msdp sa-cache-server <remoteaddr> {vr <vrname>}
```

To purge all SA cache entries, use the following command:

```
clear msdp sa-cache {{peer} <remoteaddr> | peer all} {group-address <grp-addr>} {vr <vrname>}
```

To display the SA cache database, use the following command:

```
show msdp [sa-cache | rejected-sa-cache] {group-address <grp-addr>} {source-address <src-addr>} {as-number <as-num>} {originator-rp <originator-rp-addr>} {local} {peer <remoteaddr>} {vr <vrname>}
```

Maximum SA Cache Entry Limit

You can configure a limit on the maximum number of SA cache entries that can be stored in the cache database. Once the number of SA cache entries exceeds the pre-configured limit, any newly received

cache entries are discarded. You can configure the limit on a per-peer basis. By default, no SA message limit is set. The router can receive an unlimited number of SA entries from an MSDP peer.

To configure a limit on the number of SA entries that can be stored in cache, use the following command:

```
configure msdp peer [<remoteaddr> | all] sa-limit <max-sa> {vr <vrname>}
```

To allow an unlimited number of SA entries, use 0 (zero) as the value for <max-sa>.

To display the SA cache limit, use the following command:

```
show msdp [peer {detail} | {peer} <remoteaddr>] {vr <vrname>}
```

Redundancy

Because the peering relationship between MSDP peers is based on TCP connections, after a failover occurs the TCP connections need to be re-established again. All SA cache entries learned from the old peering relationships must be flushed and relearned again on new TCP connections.

On a dual MSM system, MSDP runs simultaneously on both MSMs. During failover, the MSDP process on the active MSM receives and processes all control messages. MSDP on the standby MSM is in a down state, and doesn't receive, transmit, or process any control messages. If the active MSM fails, the MSDP process loses all state information and the standby MSM becomes active. However, the failover from the active MSM to the standby MSM causes MSDP to lose all state information and dynamic data, so it is not a hitless failover.

On fixed-configuration, stackable switches, an MSDP process failure brings down the switch.

Scaling Limits

Table 136: MSDP Scaling Limits

Platform Type	MSDP Peering Connections (Active TCP Connections)	Entries in SA Cache	Mesh-Groups
Chassis	32	16,000	8
Stackable	16	8,000	8
PC	12	8,000	4

SNMP MIBs

SNMP MIB access is not supported for MSDP.

Configuration Examples

This section provides the following configuration examples:

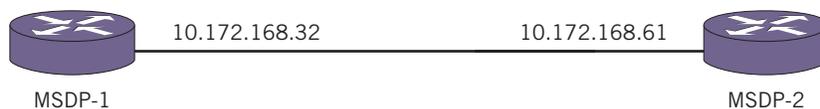
- [Configuring MSDP on page 1453](#)
- [Configuring an MSDP Mesh-Group on page 1454](#)
- [Configuring Anycast RP on page 1456](#)

Configuring MSDP

Figure 236 shows two MSDP-speaking routers, MSDP-1 and MSDP-2. The example in this section shows how to configure MSDP on each router to:

- Establish a peer session between MSDP-1 and MSDP-2. (To verify the session, enter the `show msdp peer` command.)
- Exchange SA messages, if any, between MSDP-1 and MSDP-2. (To view the SA cache database, enter the `show msdp sa-cache` command.)

Figure 236: MSDP Configuration Example



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The minimum configuration required to establish an MSDP session between MSDP-1 and MSDP-2 follows.

Configuration for MSDP-1

```
# VLAN configuration
create vlan test
config vlan test ipaddress 10.172.168.32/24
config default del port 1:1
config vlan test add port 1:1
enable ipforwarding

# MSDP configuration
config msdp originator-id 10.172.168.32
create msdp peer 10.172.168.61
enable msdp peer 10.172.168.61
enable msdp
```

Configuration for MSDP-2

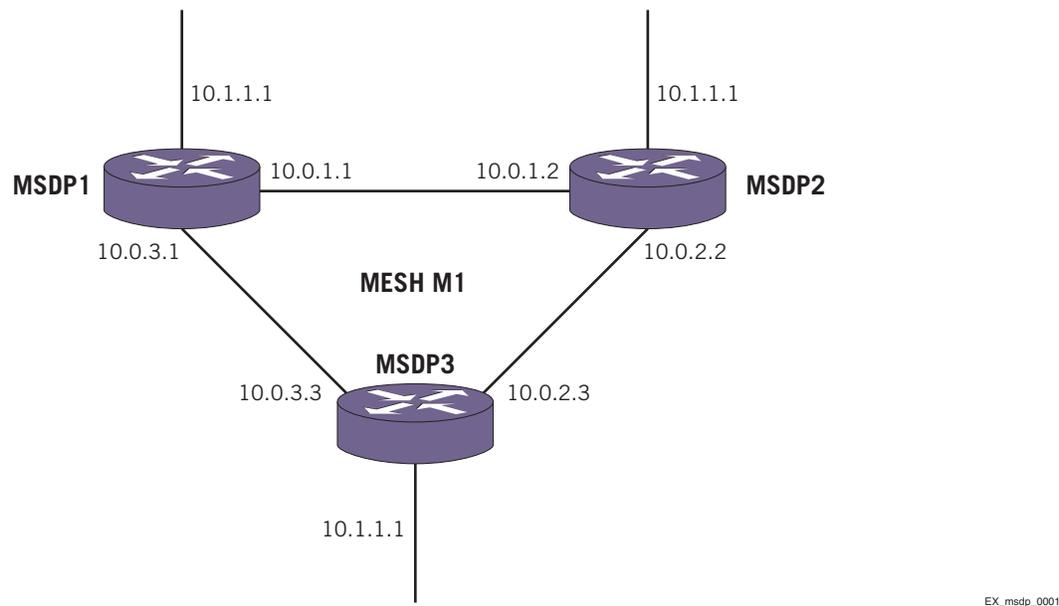
```
# VLAN configuration
create vlan test
config vlan test ipaddress 10.172.168.61/24
config default del port 1:1
config vlan test add port 1:1
enable ipforwarding
```

```
# MSDP configuration
config msdp originator-id 10.172.168.61
create msdp peer 10.172.168.32
enable msdp peer 10.172.168.32
enable msdp
```

Configuring an MSDP Mesh-Group

Figure 237 shows an example MSDP mesh group configuration.

Figure 237: MSDP Mesh-Group Configuration



In this example:

- MSDP 1, MSDP 2, and MSDP 3 are configured in a mesh-group called *M1*.
- When the SA message is received at MSDP 1 on interface 10.1.1.1, MSDP 1 floods the message to MSDP 2 and MSDP 3.
- MSDP 2 inserts the SA message, but the message is not forwarded to MSDP 3 because it is in the same mesh-group.
- MSDP 3 inserts the SA message, but the message is not forwarded to MSDP 2 because it is in the same mesh-group.

As this examples shows, a mesh-group limits the flooding of SA messages to neighboring peers in the mesh-group.

In the configurations, loopback VLANs are used as the MSDP peer addresses. This is the recommended practice for MSDP. The same can be configured for the originator RP address also (CBSR and CRP also can be used as the loopback IP addresses).

In the topology, loopback VLANs are configured on each of the switches and the loopback addresses for each of the switches are as follows:

- MSDP 1 (10.1.1.1/32)
- MSDP 2 (10.1.1.2/32)
- MSDP 3 (10.1.1.3/32)

**NOTE**

The autonomous system (AS) number for the peer is used in peer-RPF checks. The AS number provided by the user is treated as the AS number in which the peer resides. If you do not specify an AS number, BGP is used to determine the AS number for the peer. If the peer is reachable by other routes, BGP will not be able to determine the AS number for the peer.

The following sections provide additional information on the MSDP configuration portion of this example:

- [Switch MSDP1 Configuration Commands on page 1455](#)
- [Switch MSDP2 Configuration Commands on page 1455](#)
- [Switch MSDP3 Configuration Commands on page 1456](#)

**NOTE**

For an example of the VLAN and PIM configuration that supports MSDP in this example, see the next example, [“Configuring Anycast RP” on page 1456](#), which is similar to this example.

Switch MSDP1 Configuration Commands. The following is an example MSDP configuration for switch MSDP1:

```
create msdp peer 10.0.1.2
configure msdp peer 10.0.1.2 decription "msdp_22"
configure msdp peer 10.0.1.2 password "test"
create msdp peer 10.0.3.3
configure msdp peer 10.0.3.3 password "test"
configure msdp peer 10.0.3.3 decription "msdp_13"

create msdp mesh-group m1
configure msdp peer 10.0.1.2 mesh-group m1
configure msdp peer 10.0.3.3 mesh-group m1

configure msdp originator-id 10.0.1.1 /To configure unique originator id

enable msdp peer all
enable msdp
```

Switch MSDP2 Configuration Commands. The following is an example MSDP configuration for switch MSDP2:

```
create msdp peer 10.0.1.1
configure msdp peer 10.0.1.1 decription "msdp_21"
configure msdp peer 10.0.1.1 password "test"
create msdp peer 10.0.2.3
configure msdp peer 10.0.2.3 password "test"
configure msdp peer 10.0.2.3 decription "msdp_23"

create msdp mesh-group m1
```

```
configure msdp peer 10.0.1.1 mesh-group m1
configure msdp peer 10.0.2.3 mesh-group m1

configure msdp originator-id 10.0.2.2 /To configure unique originator id

enable msdp peer all
enable msdp
```

Switch MSDP3 Configuration Commands. The following is an example MSDP configuration for switch MSDP3:

```
create msdp peer 10.0.3.1
configure msdp peer 10.0.3.1 description "msdp_31"
configure msdp peer 10.0.3.1 password "test"
create msdp peer 10.0.2.2
configure msdp peer 10.0.2.2 password "test"
configure msdp peer 10.0.2.2 description "msdp_13"

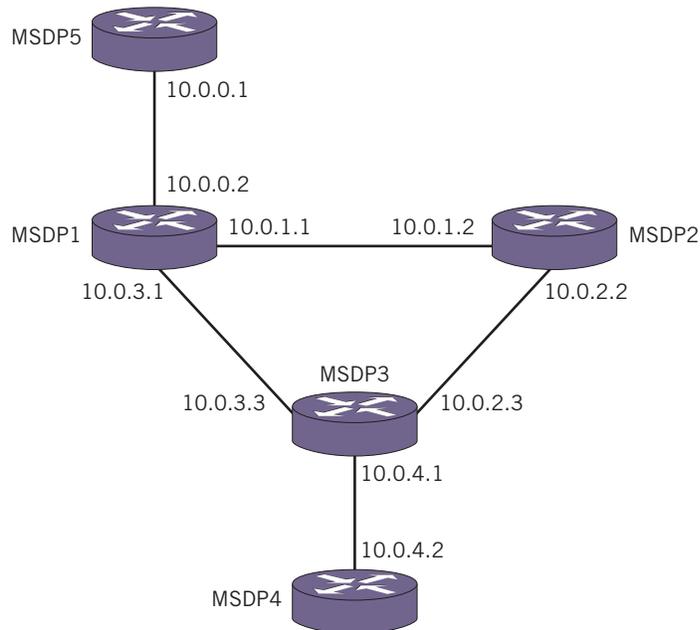
create msdp mesh-group m1
configure msdp peer 10.0.3.1 mesh-group m1
configure msdp peer 10.0.2.2 mesh-group m1

configure msdp originator-id 10.0.3.3 /To configure unique originator id

enable msdp peer all
enable msdp
```

Configuring Anycast RP

Figure 238 shows the mesh-group *M1*, which is comprised of three MSDP peers: MSDP 1, MSDP 2, and MSDP 3. MSDP 5 is connected to MSDP 1, and MSDP 4 is connected to MSDP 3; however, they are not part of the mesh-group.

Figure 238: MSDP Anycast RP Configuration

EX_msdp_0002

In [Figure 238](#), all five routers are configured with the same loopback VLAN IP address (1.1.1.1/32), and this address is configured in each router as an RP in the PIM SM domain. Three RP routers (*MSDP1*, *MSDP2*, and *MSDP3*) are configured in the MSDP mesh topology. The unicast routing mechanism ensures that all the non-RP routers in the domain route join requests to the closest RP router.

**NOTE**

The anycast RP address must be unique to the loopback VLAN and be the same on all anycast RP peers. It must not match the router IP address, the PIM BSR address, or any other IP address used by the router or any other network device.

The following sections provide example configurations for the switches shown in [Figure 238](#):

- [MSDP 1 Configuration on page 1457](#)
- [MSDP 2 Configuration on page 1458](#)
- [MSDP 3 Configuration on page 1459](#)
- [MSDP 4 Configuration on page 1459](#)
- [MSDP 5 Configuration on page 1460](#)

MSDP 1 Configuration

```

# VLAN configuration
create vlan v_anycast
configure vlan "v_anycast" ipaddress 1.1.1.1/32
enable loopback-mode vlan "v_anycast"
enable ipforwarding vlan "v_anycast"
enable ipmcforwarding vlan "v_anycast"

```

```
# OSPF configuration to inject routes into routing protocols
configure ospf add vlan "v_anycast" area 0.0.0.0

# PIM-SM configuration
configure pim add vlan "v_anycast" sparse
configure pim crp static 1.1.1.1 rp_policy

# MSDP configuration
configure msdp originiator id 10.1.1.4
create msdp peer 10.1.1.5
create msdp peer 10.1.1.2
create msdp peer 10.1.1.3
configure msdp peer all source-interface 10.1.1.1

create msdp mesh-group m1
configure msdp peer 10.1.1.2 mesh-group m1
configure msdp peer 10.1.1.3 mesh-group m1

enable msdp peer all
enable msdp
```

MSDP 2 Configuration

```
# VLAN configuration
create vlan v_anycast
configure vlan "v_anycast" ipaddress 1.1.1.1/32
enable loopback-mode vlan "v_anycast"
enable ipforwarding vlan "v_anycast"
enable ipmcforwarding vlan "v_anycast"

# OSPF configuration to inject routes into routing protocols
configure ospf add vlan "v_anycast" area 0.0.0.0

# PIM-SM configuration
configure pim add vlan "v_anycast" sparse
configure pim crp static 1.1.1.1 rp_policy

# MSDP configuration
configure msdp originiator id 10.1.1.2
create msdp peer 10.1.1.1
create msdp peer 10.1.1.3
configure msdp peer all source-interface 10.1.1.2

create msdp mesh-group m1
configure msdp peer 10.1.1.1 mesh-group m1
configure msdp peer 10.1.1.3 mesh-group m1

enable msdp peer all
enable msdp
```

MSDP 3 Configuration

```
# VLAN configuration
create vlan v_anycast
configure vlan "v_anycast" ipaddress 1.1.1.1/32
enable loopback-mode vlan "v_anycast"
enable ipforwarding vlan "v_anycast"
enable ipmcforwarding vlan "v_anycast"

# OSPF configuration to inject routes into routing protocols
configure ospf add vlan "v_anycast" area 0.0.0.0

# PIM-SM configuration
configure pim add vlan "v_anycast" sparse
configure pim crp static 1.1.1.1 rp_policy

# MSDP configuration
configure msdp originator id 10.1.1.3
create msdp peer 10.1.1.1
create msdp peer 10.1.1.2
create msdp peer 10.1.1.4
configure msdp peer all source-interface 10.1.1.3

create msdp mesh-group m1
configure msdp peer 10.1.1.1 mesh-group m1
configure msdp peer 10.1.1.2 mesh-group m1

enable msdp peer all
enable msdp
```

MSDP 4 Configuration

```
# VLAN configuration
create vlan v_anycast
configure vlan "v_anycast" ipaddress 1.1.1.1/32
enable loopback-mode vlan "v_anycast"
enable ipforwarding vlan "v_anycast"
enable ipmcforwarding vlan "v_anycast"

# OSPF configuration to inject routes into routing protocols
configure ospf add vlan "v_anycast" area 0.0.0.0

# PIM-SM configuration
configure pim add vlan "v_anycast" sparse
configure pim crp static 1.1.1.1 rp_policy

# MSDP configuration
configure msdp originator id 10.1.1.4
create msdp peer 10.1.1.3
configure msdp peer all source-interface 10.1.1.4

enable msdp peer all
enable msdp
```

MSDP 5 Configuration

```
# VLAN configuration
create vlan v_anycast
configure vlan "v_anycast" ipaddress 1.1.1.1/32
enable loopback-mode vlan "v_anycast"
enable ipforwarding vlan "v_anycast"
enable ipmcforwarding vlan "v_anycast"

# OSPF configuration to inject routes into routing protocols
configure ospf add vlan "v_anycast" area 0.0.0.0

# PIM-SM configuration
configure pim add vlan "v_anycast" sparse
configure pim crp static 1.1.1.1 rp_policy

# MSDP configuration
configure msdp originator id 10.1.1.5
create msdp peer 10.1.1.1
configure msdp peer all source-interface 10.1.1.5

enable msdp peer all
enable msdp
```

3 PART

Appendixes

A

APPENDIX

Feature License Requirements

This appendix introduces the licenses and feature packs available for the ExtremeXOS software and lists the features they support. This appendix includes the following sections:

- [Overview on page 1463](#)
- [Displaying the Installed Licenses and Feature Packs on page 1464](#)
- [Switch License Features on page 1465](#)
- [Feature Pack Features on page 1472](#)



NOTE

For information on obtaining and managing licenses and feature packs, see [Appendix B, “Software Upgrade and Boot Options.”](#)

Overview

The ExtremeXOS software supports the following license options:

- L2 Edge
- Edge
- Advanced Edge
- Core
- Feature packs

The L2 Edge license provides a basic feature set and the Core license includes the highest level of functionality. Each license level builds on the features of the license level below it. For example, the Advanced Edge license includes all of the features in the L2 Edge and Edge licenses, plus the features in the Advance Edge license. The Core license includes all of the features in the Advanced Edge license, plus the features in the Core license. See [Table 137](#) for a list of software licenses available for each platform that supports ExtremeXOS software.



NOTE

The Advanced Core license is no longer offered.

Table 137: Standard and Upgrade Licenses for ExtremeXOS Switches

Switch Platform	L2 Edge License	Edge License	Advanced Edge License	Core License
Summit X150 series	Standard	—	—	—
Summit X250e series	—	Standard	Upgrade	—
Summit X350 series	Standard	—	—	—
Summit X450a series	—	—	Standard	Upgrade
Summit X440 series	—	Standard	Upgrade	—
Summit X440-L2	Standard	—	—	—
Summit X450e series	—	Standard	Upgrade	—
Summit X460 series	—	Standard	Upgrade	Upgrade
Summit X480 series	—	—	Standard	Upgrade
Summit X650 series	—	—	Standard	Upgrade
Summit X670 series	—	—	Standard	Upgrade
E4G-200	—	Standard	Upgrade	Upgrade
E4G-400	—	—	Standard	Upgrade
BlackDiamond X8 series	—	—	Standard	Upgrade
BlackDiamond 8800 series	—	—	Standard	Upgrade

Software keys are stored in the EEPROM of the chassis and, once enabled, persist through reboots, software upgrades, power outages, and reconfigurations. Because the license is stored in the EEPROM of the chassis (and not on the MSM/MM card), the license persists even if you change MSM/MM cards. The keys are unique to the chassis or switch and are not transferable.

If you attempt to execute a command and you either do not have the required license or have reached the limits defined by the current license level, the system returns one of the following messages:

```
Error: This command cannot be executed at the current license level.
Error: You have reached the maximum limit for this feature at this license level.
```

You can obtain a trial license, which allows you to use the license for 30, 60, or 90 days, and you can downgrade trial licenses to a lower software license level during the trial period. After you enable the trial license, the switch behaves as if all software license levels and feature packs were enabled. The trial license key contains all the necessary information on the license level and the number of days. Once you have a trial license for any one of these periods, you cannot extend the time of the trial. And, trial licenses can be applied only once for each software version; if you upgrade to a different software version, you can reapply your trial license.

Displaying the Installed Licenses and Feature Packs

You can display the types of licenses and feature packs installed on your Extreme Networks switch by using the `show licenses` command.

Switch License Features

The following sections list the features for the switch license levels and feature packs:

- [L2 Edge License Features on page 1465](#)
- [Edge License Features on page 1468](#)
- [Advanced Edge License Features on page 1470](#)
- [Core License Features on page 1471](#)

L2 Edge License Features

The L2 Edge license provides all Layer-2 switch applicable capabilities of the ExtremeXOS software that are not licensed by the higher license levels (the Edge, Advanced Edge, and Core licenses) and the Feature Packs. [Table 138](#) lists most of the L2 Edge license features.

Table 138: ExtremeXOS L2 Edge License Features

ExtremeXOS Software Feature	Supported Platforms ^a
EDP	All platforms
Extreme Network Virtualization (XNV)	All platforms
Identity Management	Summit family switches SummitStack BlackDiamond 8000 series
LLDP 802.1ab	Summit family switches SummitStack BlackDiamond 8000 series
LLDP-MED extensions	Summit family switches SummitStack BlackDiamond 8000 series
VLANs—Port based and tagged trunks	All platforms
VLANs—MAC based	All platforms
VLANs—Protocol based	Summit family switches BlackDiamond 8000 series
VLANs—Private VLANs	All platforms
VLANs—VLAN translation	All platforms
VMANs—Q-in-Q tunneling (IEEE 802.1ad VMAN tunneling standard)	All platforms
VMANs—Egress queue selection based on 802.1p value in S-tag	All platforms
VMANs—Egress queue selection based on 802.1p value in C-tag	Summit family switches SummitStack BlackDiamond 8000 series
VMANs—Secondary ethertype support	All platforms
VMAN Customer Edge Port (CEP—also known as <i>Selective Q-in-Q</i>)	BlackDiamond 8000 series Summit family switches
VMAN Customer Edge Port <ul style="list-style-type: none"> • CVID Egress Filtering • CVID Translation 	Summit X460, X480, X650, and X670 series switches BlackDiamond 8900 c-, xl-, and xm-series modules.
L2 Ping / Traceroute 802.1ag	All platforms

Table 138: ExtremeXOS L2 Edge License Features (Continued)

ExtremeXOS Software Feature	Supported Platforms^a
Jumbo frames (including all related items, MTU disc. IP frag.)	All platforms
QoS—egress port rate shaping/limiting	All platforms
QoS—egress queue rate shaping/limiting	All platforms
Link Aggregation Groups (LAG), static 802.3ad	All platforms
LAG dynamic (802.3ad LACP) edge, to servers only!	All platforms
LAG (802.3ad LACP) core, between switches	All platforms
Port loopback detection and shutdown (ELRP CLI)	All platforms
Software redundant port	All platforms
STP 802.1D	All platforms
STP EMISTP + PVST+ Compatibility mode (1 domain per port)	All platforms
STP EMISTP, PVST+ Full (multi-domain support)	All platforms
STP 802.1s	All platforms
STP 802.1w	All platforms
ERPS (4 max rings with matching ring ports)	BlackDiamond 8000 series Summit family switches
ESRP aware	All platforms
EAPS edge (4 max domains with matching ring ports)	All platforms
Link Fault Signaling (LFS)	All platforms
ELSM (Extreme Link Status Monitoring)	All platforms
ACLs, applied on ingress ports <ul style="list-style-type: none"> • IPv4 • Static 	All platforms
ACLs, applied on ingress ports <ul style="list-style-type: none"> • IPv6 • Dynamic 	Summit family switches SummitStack BlackDiamond 8000 series
ACLs, applied on egress ports	Summit X460, X480, X650, and X670 series switches BlackDiamond 8000 c-, xl-, and xm-series modules
ACLs, ingress meters	Summit family switches SummitStack BlackDiamond 8000 series
ACLs, egress meters	Summit X460, X480, X650, and X670 series switches BlackDiamond 8000 c-, xl-, and xm-series modules
ACLs <ul style="list-style-type: none"> • Layer-2 protocol tunneling • Byte counters 	Summit family switches SummitStack BlackDiamond 8000 series
MSM/MM hitless failover for STP	BlackDiamond 8000 series
MSM hitless failover for ESRP	BlackDiamond 8000 series
MSM/MM hitless failover - Additional capabilities: EAPS, NetLogin, PoE. Graceful Restart for OSPF, BGP	BlackDiamond 8000 series

Table 138: ExtremeXOS L2 Edge License Features (Continued)

ExtremeXOS Software Feature	Supported Platforms^a
CPU DoS protect	All platforms
CPU Monitoring	All platforms
SNMPv3	All platforms
SSH2 server	All platforms
SSH2 client	All platforms
SCP/SFTP client	All platforms
SCP/SFTP server	All platforms
RADIUS and TACACS+ per command authentication	All platforms
Network login <ul style="list-style-type: none"> • Web based method • 802.1x method • MAC based method • Local database for MAC/Web based methods • Integration with Microsoft NAP • Multiple supplicants - same VLAN • HTTPS/SSL for web-based method 	Summit family switches SummitStack BlackDiamond 8000 series
Network login—Multiple supplicants - multiple VLANs	Summit Family switches BlackDiamond 8000 series
Trusted OUI	All platforms
MAC security <ul style="list-style-type: none"> • Lockdown • Limit 	Summit family switches SummitStack BlackDiamond 8000 series
IP security—DHCP Option 82—L2 mode	All platforms
IP security—DHCP Option 82—L2 mode VLAN ID	All platforms
IP security—DHCP IP lockdown	All platforms
IP security—Trusted DHCP server ports	All platforms
Static IGMP membership, IGMP filters	All platforms
IPv4 unicast L2 switching	All platforms
IPv4 multicast L2 switching	All platforms
IPv4 directed broadcast	Summit family switches SummitStack BlackDiamond 8000 series
IPv4 <ul style="list-style-type: none"> • Fast-direct broadcast • Ignore broadcast 	Summit X250e, X350, X450, X450a, X450e, X460, X480, X650, and X670 series switches BlackDiamond 8000 series
IPv6 unicast L2 switching	All platforms
IPv6 multicast L2 switching	All platforms
IPv6 netTools—Ping, traceroute, BOOTP relay, DHCP, DNS, and SNTP.	All platforms
IGMP v1/v2 snooping	All platforms
IGMP v3 snooping	All platforms
Multicast VLAN Registration (MVR)	All platforms

Table 138: ExtremeXOS L2 Edge License Features (Continued)

ExtremeXOS Software Feature	Supported Platforms ^a
Static MLD membership, MLD filters	All platforms
MLD v1 snooping	All platforms
MLD v2 snooping	All platforms
sFlow accounting	Summit family switches BlackDiamond 8000 series
CLI scripting	All platforms
Web-based device management	All platforms
Web based management—HTTPS/SSL support	All platforms
XML APIs (for partner integration)	All platforms
MIBs - Entity, for inventory	All platforms
Connectivity Fault Management (CFM)	All platforms
Remote mirroring	All platforms
Egress mirroring	Summit family switches SummitStack BlackDiamond 8000 series
Y.1731 compliant frame delay and delay variance measurement	All platforms
EFM OAM unidirectional link fault management	Summit X450a switches

a. Listed platforms that do not support this license support these features with a higher license level.

Edge License Features

The Edge License adds L3 routing and switching to the list of L2 features supported by the L2 Edge license. [Table 139](#) lists the features included in the Edge License.

Table 139: ExtremeXOS Edge License Features

ExtremeXOS Software Feature	Supported Platforms ^a
CLEAR-Flow	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
System virtual routers (VRs)	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
User-created Virtual Routers (VRs) Virtual Router and Forwarding (VRF)	Summit X460, X480, X650, and X670 series BlackDiamond 8000 c- and xl-series modules E4G-200, E4G-400 and BX8 series
VLAN aggregation	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
Multinetting for forwarding	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
UDP Forwarding	Summit X250e, X450a, X450e, X460, X480, X650, and X670 series BlackDiamond 8000 series
UDP BootP relay forwarding	Summit X250e, X450a, X450e, X460, X480, X650, and X670series BlackDiamond 8000 series
IPv4 unicast routing, including static routes	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)

Table 139: ExtremeXOS Edge License Features (Continued)

ExtremeXOS Software Feature	Supported Platforms ^a
IPv4 multicast routing, including static routes	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
IPv4 Duplicate Address Detection (DAD)	Summit family switches SummitStack BlackDiamond 8000 series
IPv6 unicast routing, including static routes	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
IPv6 interworking—IPv6-to-IPv4 and IPv6-in-IPv4 configured tunnels	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
IPv6 Duplicate Address Detection (DAD) without CLI management	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
IPv6 Duplicate Address Detection (DAD) with CLI management	Summit family switches SummitStack BlackDiamond 8000 series
IP security: <ul style="list-style-type: none"> • DHCP Option 82—L3 mode • DHCP Option 82—L3 mode VLAN ID • Disable ARP learning • Gratuitous ARP protection • DHCP secured ARP / ARP validation 	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
IP address security: <ul style="list-style-type: none"> • DHCP snooping • Trusted DHCP server • Source IP lockdown • ARP validation 	Summit X250e, X440, X450, X460, X480, X650, and X670 series BlackDiamond 8000 series
IP Flow Information Export (IPFIX)	BlackDiamond 8900 G96Tc, G48T-xl, G48X-xl and 10G8X-xl modules Summit X460 and X480 switches E4G-400 cell site routers
Multi-Switch Link Aggregation Group (MLAG)	BlackDiamond 8800 Series Modules Summit family switches SummitStack
Policy based routing (PBR) for IPv4	Summit X250, X450a, X450e, X460, X480, X650, and X670 switches BlackDiamond 8000 series modules
Policy based routing (PBR) for IPv6	Summit X460, X480, X650, and X670 series switches SummitStack BlackDiamond 8900 c- and xl-series modules
PIM snooping	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
Protocol-based VLANs	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
RIP v1/v2	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
RIPng	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)

Table 139: ExtremeXOS Edge License Features (Continued)

ExtremeXOS Software Feature	Supported Platforms ^a
Routing access policies	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
Route maps	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
Universal Port—VoIP auto configuration	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
Universal Port—Dynamic user-based security policies	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
Universal Port—Time-of-day policies	All platforms that support the Edge, Advanced Edge, and Core licenses (see Table 137)
SummitStack (switch stacking using native or dedicated ports)	Summit X250, X440-24p, X440-24t, X440-8p and X440-48p using dedicated SummitStack ports, X450a, X450e, and X460 family switches, and E4G-400 with a SummitStack or SummitStack V-80 module Summit X480 family switches with a VIM2-SummitStack, VIM2-SummitStack-V80, or VIM2-SummitStack128 module Summit X650 family switches with a VIM1-SummitStack, VIM1-SummitStack256, VIM1-SummitStack512, or VIM3-40G4X module Summit X670V switches with a VIM4-40G4X module
SummitStack-V (switch stacking using dual purpose data ports)	See the platforms listed in Table 23 .

a. Listed platforms that do not support this license support these features with a higher license level.

Advanced Edge License Features

The Advanced Edge License includes all Edge License features and the features in [Table 140](#).

Table 140: ExtremeXOS Advanced Edge License Features

ExtremeXOS Software Feature	Supported Platforms ^a
VRRP	All platforms that support the Advanced Edge and Core licenses (see Table 137)
ERPS-more domains (allows 32 rings with matching ring ports)	BlackDiamond 8000 series Summit family switches
ESRP-Full	Summit X250e, X450a, X450e, X460, X480, X650, and X670 series BlackDiamond 8000 series
ESRP-Virtual MAC	BlackDiamond 8000 series Summit family switches
OSPFv2-Edge (limited to max of 4 active interfaces)	All platforms that support the Advanced Edge and Core licenses (see Table 137)

Table 140: ExtremeXOS Advanced Edge License Features (Continued)

ExtremeXOS Software Feature	Supported Platforms ^a
OSPFv3-Edge (limited to max of 4 active interfaces)	All platforms that support the Advanced Edge and Core licenses (see Table 137)
PIM-SM-Edge (limited to max of 2 active interfaces)	All platforms that support the Advanced Edge and Core licenses (see Table 137)

a. Listed platforms that do not support this license support these features with a higher license level.

Core License Features

The Core License includes all Edge License features, Advanced Edge License features, and the features in [Table 141](#).

Table 141: ExtremeXOS Core License Features

ExtremeXOS Software Feature	Supported Platforms
EAPS "Full" (multiple rings with multiple interconnect points and common links)	Core license platforms listed in Table 137 .
ERPS "Full" (multiple rings)	BlackDiamond 8000 series Summit family switches
PIM DM "Full"	Core license platforms listed in Table 137 .
PIM SM "Full"	Core license platforms listed in Table 137 .
PIM SSM "Full"	Core license platforms listed in Table 137 .
OSPFv2 "Full" (not limited to 4 active interfaces)	Core license platforms listed in Table 137 .
OSPFv3 "Full" (not limited to 4 active interfaces)	Core license platforms listed in Table 137 .
BGP4 and MBGP (BGP4+) for IPv4 <ul style="list-style-type: none"> • ECMP 	Core license platforms listed in Table 137 .
BGP4 and MBGP (BGP4+) for IPv6	Core license platforms listed in Table 137 .
IS-IS for IPv4	Core license platforms listed in Table 137 .
IS-IS for IPv6	Core license platforms listed in Table 137 .
MSDP	Core license platforms listed in Table 137 .
Anycast RP	Core license platforms listed in Table 137 .
HQoS <ul style="list-style-type: none"> • Ingress rate limiting • Strict priority mode 	BlackDiamond 12800-R series

Feature Pack Features

The ExtremeXOS software features are listed in [Table 142](#) are managed as *feature packs*.

Table 142: ExtremeXOS Feature Pack Features

Feature Pack	Feature	Platform Support
CNA Feature Pack	<ul style="list-style-type: none"> Provides the client software to work with the Converged Network Analyzer (CNA) software from Avaya Inc.® 	All platforms.
Direct Attach Feature Pack	<ul style="list-style-type: none"> Direct attach 	Summit X450a, X460, X480, X650, and X670 switches BlackDiamond 8800 series switches BlackDiamond X8 series switches
MPLS Feature Pack (IPv4 only)	<ul style="list-style-type: none"> MPLS LDP Static LSPs OSPF-TE MPLS label EXP bit replacement and classification RSVP-TE VPLS H-VPLS for VLANs VPLS STP Redundancy VPWS With ESRP redundant access Fast reroute (FRR) Support for PW counters User virtual routers	Summit X460 ^a , X480, and X670 switches E4G-200 and E4G-400 cell site routers ^b BlackDiamond 8900 xl-series modules ^c BlackDiamond 8900 xm-series modules ^d BlackDiamond X8 series switches
Legacy CLI Feature Pack	<ul style="list-style-type: none"> Support for legacy CLI commands 	All platforms

Table 142: ExtremeXOS Feature Pack Features (Continued)

Feature Pack	Feature	Platform Support
Network Timing Feature Pack	<ul style="list-style-type: none"> Precision Time Protocol (PTPv2) 	E4G-200 and E4G-400 cell site routers
SSH Feature Pack	<ul style="list-style-type: none"> Secure Shell 2 (SSH2) Secure Copy Protocol 2 (SCP2) Secure File Transfer Protocol (SFTP) 	All platforms

- Summit X460 switches require the Advanced Edge or Core license to support MPLS.
- For the E4G-200, you obtain the MPLS feature pack by upgrading to an Advanced Edge license. For the E4G-400, the Advanced Edge license is standard and already includes the MPLS feature pack.
- To run MPLS with BlackDiamond 8900 xl-series modules, a BlackDiamond 8800 series switch requires ExtremeXOS Release 12.5 or later, BlackDiamond 8900-MSM128, and BlackDiamond 8900 xl-series modules. No other modules are supported when MPLS runs on a BlackDiamond 8800 series switch with ExtremeXOS 12.5.
- To run MPLS with BlackDiamond 8900 xm-series modules, a BlackDiamond 8800 series switch requires ExtremeXOS Release 12.6 or later, BlackDiamond 8900-MSM128, and BlackDiamond 8900 xl- or xm-series modules. No other modules are supported when MPLS runs on a BlackDiamond 8800 series switch with ExtremeXOS 12.6 or later.

Feature packs are distributed in one of the following forms:

- Software component within ExtremeXOS software
- Modular software package, which is also known as an *xmod* file (due to the *xmod* filename extension)

To start using a feature pack that is a component of ExtremeXOS, you must purchase a license to use the feature pack as described in [Appendix B, “Software Upgrade and Boot Options.”](#)

To start using a feature pack that is distributed in a modular software package, you must request the *xmod* file from your supplier and install it as described in [“Installing a Modular Software Package” on page 1483.](#)

**NOTE**

The SSH feature pack is the exception to the above rules. The SSH feature pack is distributed in a modular software package and requires a license before feature operation. There is no charge for the license.

For information on installing feature packs, see [Appendix B, “Software Upgrade and Boot Options.”](#) The following sections provide additional information on these feature packs:

- [CNA Feature Pack on page 1473](#)
- [Direct Attach Feature Pack on page 1474](#)
- [Legacy CLI Feature Pack on page 1474](#)
- [MPLS Feature Pack \(IPv4 Only\) on page 1474](#)
- [Network Timing Feature Pack on page 1474](#)
- [SSH Feature Pack on page 1475](#)

CNA Feature Pack

The CNA feature pack is distributed in an modular software package and provides the client software required to work with the Converged Network Analyzer (CNA) software from Avaya Inc.®

For more information on CNA, see [Appendix C, “CNA Agent.”](#)

Direct Attach Feature Pack

The Direct Attach feature, which is based on the IEEE version of VEPA, eliminates the virtual switch layer, simplifying the network and improving performance. Direct Attach enables data center simplification by reducing network tiers from 4 or 5 tiers to just 3 or 2 tiers, depending on the size of the data center.

This feature pack is included with all ExtremeXOS software licenses and can be enabled by purchasing and enabling a feature pack license key.

For more information the direct attach feature, see [“Managing Direct Attach to Support VEPA” on page 635.](#)

Legacy CLI Feature Pack

The Legacy CLI feature enables those who have experience with legacy, mode-based CLIs to use familiar commands to start using the ExtremeXOS software using commands they already know.

The Legacy CLI feature is distributed in a file that you can download and install as described in [Appendix B, “Software Upgrade and Boot Options.”](#)

For more information on the Legacy CLI feature, see the *Legacy CLI Quick Reference Guide*.

MPLS Feature Pack (IPv4 Only)



NOTE

The MPLS Feature Pack features are supported only on the platforms listed in [Table 142](#). BlackDiamond 8800 series switches require specific software and hardware to support MPLS, and these requirements are specified [Table 142](#).

MPLS support, including VPLS L2 VPNs, can be obtained from Extreme Networks at an additional cost, as a feature pack. A separate feature pack must be purchased for each switch that will run MPLS and VPLS.

On BlackDiamond 20800 series switches, the MPLS Feature Pack also adds support for PBBN.

This feature pack is included with the Advanced Edge and Core software licenses and can be enabled by purchasing and enabling a feature pack license key.

After you enable the feature pack, the feature CLI commands are visible; without an enabled MPLS feature pack, you do not see any feature commands on the console.

Network Timing Feature Pack

The Network Timing Feature Pack supports the Precision Time Protocol (PTPv2) feature on the E4G-200 and E4G-400 cell site routers.

This feature pack is included with all ExtremeXOS software licenses and can be enabled by purchasing and enabling a feature pack license key.

For more information about PTPv2, see [“Using the Simple Network Management Protocol”](#) in [Chapter 2, “Managing the Switch”](#).

SSH Feature Pack

Secure Shell 2 (SSH2) is a feature of the ExtremeXOS software that allows you to encrypt session data between a network administrator using SSH2 client software and the switch or to send encrypted data from the switch to an SSH2 client on a remote system. Configuration, image, public key, and policy files can be transferred to the switch using the Secure Copy Protocol 2 (SCP2) or the Secure File Transfer Protocol (SFTP).

SSH contains strong encryption algorithms which heighten the export controls required in the US and other countries. Once the export clearance requirements are met, there is no charge to download the SSH modular software package and enable this feature. For more information, see [Appendix B, “Software Upgrade and Boot Options.”](#)

For more information on SSH2, see [“Secure Shell 2”](#) on [page 900](#).

B

APPENDIX

Software Upgrade and Boot Options

This appendix includes the following sections:

- [Downloading a New Image on page 1477](#)
- [Understanding Hitless Upgrade—Modular Switches Only on page 1486](#)
- [Configuration Changes on page 1493](#)
- [Using TFTP to Upload the Configuration on page 1498](#)
- [Using TFTP to Download the Configuration on page 1499](#)
- [Synchronizing Nodes—Modular Switches and SummitStack Only on page 1500](#)
- [Accessing the Bootloader on page 1501](#)
- [Upgrading the BootROM on page 1502](#)
- [Upgrading the Firmware on page 1503](#)
- [Displaying the BootROM and Firmware Versions on page 1506](#)

Downloading a New Image

The core image file contains the executable code that runs on the switch and is preinstalled at the factory. As new versions of this image are released, you should upgrade the software running on your system. Modular software packages enhance the functionality of the ExtremeXOS core image currently running on your switch. Modular software packages are not preinstalled at the factory.

On BlackDiamond 10808 switches, BlackDiamond 12804 switches, and BlackDiamond 8800 series switches with two MSMs installed, you can upgrade the images without taking the switch out of service. Known as a hitless upgrade, this method of downloading and installing a new image minimizes network interruption, reduces the amount of traffic lost, and maintains switch operation. For more information, see [“Understanding Hitless Upgrade—Modular Switches Only” on page 1486](#).



NOTE

Beginning with ExtremeXOS 12.1, an ExtremeXOS core image (.xos file) must be downloaded and installed on the alternate (non-active) partition. If a user tries to download to an active partition, the error message *“Error: Image can only be installed to the non-active partition.”* is displayed. An ExtremeXOS modular software package (.xmod file) can still be downloaded and installed on either the active or alternate partition.

**NOTE**

The Hitless Upgrade feature is not supported on a SummitStack or BlackDiamond X8 series.

This section describes the following topics:

- [Image Filename Prefixes on page 1478](#)
- [Understanding the Image Version String on page 1478](#)
- [Software Signatures on page 1479](#)
- [Selecting a Primary or a Secondary Image on page 1479](#)
- [Installing a Core Image on page 1480](#)
- [Installing a Modular Software Package on page 1483](#)
- [Rebooting the Switch on page 1485](#)
- [Rebooting the Management Module—Modular Switches Only on page 1486](#)
- [Rebooting a Node in a SummitStack on page 1486](#)

Image Filename Prefixes

The software image file can be an .xos file, which contains an ExtremeXOS core image, or an .xmod file, which contains an ExtremeXOS modular software package.

You can identify the appropriate image or module for your platform based on the filename of the image. [Table 143](#) lists the filename prefixes for each platform.

Table 143: Filename Prefixes

Platform	Filename Prefixes
BlackDiamond X8 series	bdX-
BlackDiamond 20800 series	bd20K-
BlackDiamond 10808	bd10K-
BlackDiamond 8810	bd8800-
BlackDiamond 8806	bd8800-
Summit family EG4-200, EG4-400	summitX-

For example, if you have a BlackDiamond 8806 switch, download image filenames with the prefix bd8800-. For additional installation requirements see the sections, [“Installing a Core Image” on page 1480](#) and [“Installing a Modular Software Package” on page 1483](#).

Understanding the Image Version String

The image version string contains build information for each version of ExtremeXOS. You can use either the `show version` or `show switch` command to display the ExtremeXOS version running on your switch.

Depending on the command line interface (CLI) command, the output is structured as follows:

- `show version`
 ExtremeXOS Version <major>.<minor>.<patch>.<build>
 For example: ExtremeXOS version 10.1.2.16
- `show switch`
 <major>.<minor>.<patch>.<build>
 For example: 10.1.2.16

Table 144 describes the image version fields.

Table 144: Image Version Fields

Field	Description
major	Specifies the ExtremeXOS major version number.
minor	Specifies the ExtremeXOS minor version number.
patch	Identifies a specific patch release.
build	Specifies the ExtremeXOS build number. This value is reset to 0 for each new major and minor release.

The `show version` command also displays information about the firmware (BootROM) images running on the switch. For more information, see [“Displaying the BootROM and Firmware Versions” on page 1506](#).

Software Signatures

Each ExtremeXOS image contains a unique signature. The BootROM checks for signature compatibility and denies an incompatible software upgrade. In addition, the software checks both the installed BootROM and software and also denies an incompatible upgrade.

Selecting a Primary or a Secondary Image

A switch can store up to two core images: a primary and a secondary. When downloading a new image, you select which partition (primary or secondary) to install the new image. You must install the software image to the alternate partition, and must specify that partition before downloading the image.

To view your current (active) partition, use the following command:

```
show switch
```

Output from this command includes the selected and booted images and if they are in the primary or secondary partition. The active partition is identified as the “booted image.” The command shows only two nodes (both MSMs/MMs in a modular chassis, or the master node and one other node in a SummitStack).

On a SummitStack, it is better to use the command

```
show slot detail
```

to see the active partition (Image Booted), selected partition for reboot (Image Selected), and ExtremeXOS versions installed in the primary and secondary partitions. This command shows the preceding information for all active nodes.

If two MSMs/MMs are installed in a modular switch, the downloaded image is saved to the same location on each one.

To select which image the switch loads on the next reboot, use one of the following commands:

```
use image {partition} <partition> {msm <slotid>} (modular switches)
use image {partition} <partition> {slot <slotid>} (SummitStack)
```

For more information on preparing a SummitStack for image upgrade, see [“Upgrading ExtremeXOS on a Stack” on page 201](#).

Installing a Core Image

Depending on your platform, you can upgrade the core image by using a download procedure from a Trivial File Transfer Protocol (TFTP) server on the network, a compact flash card installed in the compact flash slot of an MSM, or a USB 2.0 storage device connected to a BlackDiamond X8 series, Summit X460, X480, X650, X670, and X670V switch.

The information in this section describes how to install a new software image.

For information about saving an existing or new switch configuration, see [“Saving the Configuration” on page 1497](#).

For information about installing a new BootROM image on a BlackDiamond X8 or 10808 series switch or a Summit family switch, see [“Upgrading the BootROM” on page 1502](#).

For information about installing a new firmware image on a BlackDiamond 8800 series switch, see [“Upgrading the Firmware” on page 1503](#).



NOTE

When using a TFTP server to download an ExtremeXOS 12.3 image to any BlackDiamond 8800 series switch, the TFTP server must be able to handle files that are larger than 32MB or the download may fail.



NOTE

Always refer to the most recent version of the ExtremeXOS Installation and Release Notes for the most current instructions.

To download a new image:

- 1 Load the new image on one of the following devices:
 - a A network TFTP server.
 - b A compact flash card or USB 2.0 storage device.



NOTE

Compact flash slots are available on BlackDiamond 10808 and 8800 switches, and USB 2.0 storage devices are available on BlackDiamond X8 and 20800 series switches and Summit X460, X480, X650, X670, and X670V switches.

Use a PC with appropriate hardware such as a compact flash reader/writer and follow the manufacturer's instructions to access the compact flash card and place the image onto the card.

For more information about installing the compact flash cards or USB 2.0 storage devices, refer to the hardware documentation which is listed in the Preface.

- 2 If you are downloading the image from a TFTP server, use a login session on the master to verify which virtual router connects to your TFTP server. Use one of the following ping commands to confirm which virtual router reaches your TFTP server:

```
ping vr vr-Mgmt <host>
ping vr vr-Default <host>
```

At least one of these commands must successfully reach your TFTP server for you to download the image. After verifying the virtual router that reaches your TFTP server, specify that virtual router when you download the image.

- 3 Determine your booted and selected partition using the following command:

```
show switch
```

On a SummitStack, determine your booted and selected partition for all active nodes using the following command:

```
show slot detail
```

Output from this command indicates the selected and booted images and if they are in the primary or the secondary partition. The selected image partition indicates which image will be used at the next reboot. The booted image partition indicates the image used at the last reboot. It is the active partition.

- 4 Select the partition to use when downloading an image. For more information, see [“Selecting a Primary or a Secondary Image” on page 1479](#).
- 5 Download the new image to the switch using one of the following commands:

```
download image [[<hostname> | <ipaddress>] <filename> {{vr} <vrname>} | memorycard
<filename>] {<partition>} {msm <slotid>} (modular switches)
```

```
download image [[<hostname> | <ipaddress>] <filename> {{vr} <vrname>} | memorycard
<filename>] {<partition>} {slot <slot number>} (SummitStack)
```

- Before the download begins, the switch asks if you want to install the image immediately after the download is finished.

Enter `y` to install the image after download. Enter `n` to install the image at a later time.

When you install the image after download to the alternate partition, you then need to reboot the switch.

- If you install the image at a later time, the image is still downloaded and saved to the switch, but you must use the following command to install the software and reboot the switch:

```
install image <fname> {<partition>} {msm <slotid>} {reboot}
```

- **BlackDiamond 8800 Series Switches Only**—When upgrading the switch from ExtremeXOS 11.4 or earlier to ExtremeXOS 11.5, reboot the switch after downloading and installing the 11.5 image to both installed MSMs.

- **SummitStack Only**—If you see the message:

```
Error: the partition selected must not be the active partition
```

at least one node is using the wrong image partition for the image installation. See [“Upgrading ExtremeXOS on a Stack” on page 201](#) for more information on preparing a SummitStack for image download and installation.

**NOTE**

To modify or reset the software image used during a switch reboot, use the `use image` command.

**NOTE**

A secure method of upgrading the EXOS image uses SFTP or SCP2. Refer to [download image](#).

**NOTE**

When upgrading the core image to ExtremeXOS 12.5 from version 11.6 to 12.0, you should first upgrade to 12.0. From there, upgrade to 12.5 specifying the non-active partition. The switch does not prompt you to specify the non-partition but if you do not, it will fail to boot correctly at the next reboot and will then need to be recovered through the BootROM.

Using Ridgeline to Install a Core Image

Depending on your platform, you can use Ridgeline to upgrade the core image. You can either load the new image to the Ridgeline server on your network or configure Ridgeline to automatically poll and download newly released images to the Ridgeline server. Follow the instructions described in the Ridgeline documentation to appropriately configure the Ridgeline server for your network environment.

For more information about installing the Ridgeline client and server, configuring Ridgeline, and the platforms Ridgeline supports, refer to the Ridgeline documentation that comes with the product or the documentation available from the Extreme Networks website at <http://www.extremenetworks.com/services/documentation/swuserguides.asp>.

Understanding Core Dump Messages

If you configure the switch to write core dump (debug) files to the internal memory card and attempt to download a new software image, you might have insufficient space to complete the image download. If this occurs, move or delete the core dump files from the internal memory. For example, if the switch supports a compact flash card or USB 2.0 storage device and space is available, transfer the files to the storage device. On switches without removable storage devices, transfer the files from the internal memory card to a TFTP server. This frees up space on the internal memory card while keeping the core dump files.

The switch displays a message similar to the following and prompts you to take action:

```
Core dumps are present in internal-memory and must be removed before this download can
continue. (Please refer to documentation for the "configure debug core-dumps" command
for additional information)
Do you want to continue with download and remove existing core dumps? (y/n)
```

Enter `y` to remove the core dump files and download the new software image. Enter `n` to cancel this action and transfer the files before downloading the image.

Installing a Modular Software Package

In addition to the functionality available in the ExtremeXOS core image, you can add functionality to your switch by installing modular software packages or feature packs. A complete listing of these feature packs can be found with their availability requirements under [Feature Pack Features](#) in the Licensing Appendix.

Modular software packages are contained in files named with the file extension `.xmod`, while the core images use the file extension `.xos`. Modular software packages are built at the same time as core images and are designed to work in concert with the core image, so the version number of a modular software package must match the version number of the core image that it will be running with. For example, the modular software package for Secure Shell (SSH) named:

```
bd10K-11.2.0.18-ssh.xmod
```

Can run only with the core image named:

```
bd10K-11.2.0.18.xos
```

You can install a modular software package on the active partition or on the inactive partition. You would install on the active partition if you want to add the package functionality to the currently running core image without having to reboot the switch. You would install on the inactive partition if you want the functionality available after a switch reboot.

To install the package, you use the same process that you use to install a new core image. Follow the process described in the earlier section “[Installing a Core Image](#).” On BlackDiamond 10808 switches, BlackDiamond 12804 switches, and BlackDiamond 8800 series switches, you can use hitless upgrade to install the package. See “[Understanding Hitless Upgrade—Modular Switches Only](#)” on page 1486 for more information.

You activate the installed modular software package either by rebooting the switch or by issuing the following command:

```
run update
```

You can uninstall packages by issuing the following command:

```
uninstall image <fname> <partition> {msm <slotid>} {reboot}
```



NOTE

Do not terminate a process that was installed since the last reboot unless you have saved your configuration. If you have installed a software module and you terminate the newly installed process without saving your configuration, your module may not be loaded when you attempt to restart the process with the `start process` command.

This section describes the following topics:

- [Guidelines for Activating SSL](#)
- [Upgrading a Modular Software Package](#)

Guidelines for Activating SSL

Whether you are currently running SSH or downloading the SSH software module for the first time, you must complete the following steps to activate the Secure Socket Layer (SSL) functionality that is packaged with the SSH module. Before you can configure SSL on the switch, do the following:

- Download and install the SSH software module on the active partition.
- Activate the SSH software module.
- Gracefully terminate and re-start the `tthttpd` process running on the switch.

The following is an example of activating SSL on the switch:

```
download image 10.10.10.2 bd10K-11.2.0.18-ssh.xmod
run update
restart process tthttpd
```

For more information about SSH2 and SSL, see [Chapter 23, “Security.”](#)

Upgrading a Modular Software Package

When Extreme Networks introduces a new core software image, a new feature pack or modular software package is also available. If you have a software module installed and upgrade to a new core image, you need to upgrade to the corresponding feature pack.

Two methods are available to upgrade an existing modular software package on your switch. Regardless of which method you choose, you must terminate and restart the processes associated with the software module.

Method One.

- 1 Terminate the processes associated with the software module using one of the following commands:

```
terminate process <name> [forceful | graceful] {msm <slot>} (modular switches)
terminate process <name> [forceful | graceful] {slot <slotid>} (SummitStack)
```

- 2 Download the software module from your TFTP server, compact flash card, or USB 2.0 storage device using the following command:

```
download image [[<hostname> | <ipaddress>] <filename> {{vr} <vrname>} | memorycard
<filename>] {<partition>} {msm <slotid>} {slot <slotid>}
```

- 3 Activate the installed modular package, if installed on the active partition, using the following command:

```
run update
```

- 4 Restart the processes associated with the software module using one of the following commands:

```
start process <name> {msm <slot>} (modular switches)
start process <name> {slot <slotid>} (SummitStack)
```

Method Two.

- 1 Download the software module from your TFTP server, compact flash card, or USB 2.0 storage device using the following command:

```
download image [[<hostname> | <ipaddress>] <filename> {{vr} <vrname>} | memorycard
<filename>] {<partition>} {msm <slotid>} {slot <slotid>}
```

- 2 Activate the installed modular package, if installed on the active partition, using the following command:

```
run update
```

- 3 Terminate and restart the processes associated with the software module using one of the following commands:

```
restart process [class <cname> | <name> {msm <slot>}] (modular switches)
restart process [class <cname> | <name> {slot <slot>}] (SummitStack)
```

Examples. The following examples upgrade the SSH module on the active partition and assume that you have:

- Upgraded the switch to a new core image (see “[Installing a Core Image](#)” on page 1480 for more information)
- Downloaded the corresponding modular software package to your TFTP server, compact flash card, or USB 2.0 storage device (see “[Downloading a New Image](#)” on page 1477 for more information).

The first example uses the `terminate process` and `start process` commands to terminate and restart the processes associated with the software module that you are updating:

```
terminate process exsshd graceful
download image 10.10.10.2 bd10K-11.3.0.10-ssh.xmod
run update
start process exsshd
```

The second example uses the `restart process` command to terminate and restart the processes associated with the software module that you are updating:

```
download image 10.10.10.2 bd10K-11.3.0.10-ssh.xmod
run update
restart process exsshd
```

Rebooting the Switch

To reboot the switch, use one of the following commands:

```
reboot {time <month> <day> <year> <hour> <min> <sec>} {cancel} {msm <slot_id>} {slot
<slot-number> | node-address <node-address> | stack-topology {as-standby} } (modular
switches)
reboot {[time <mon> <day> <year> <hour> <min> <sec>] | cancel} {slot <slot-number> |
node-address <node-address> | stack-topology {as-standby}} (SummitStack)
```

Use this command to schedule a time to reboot the switch or to reboot the switch immediately. To schedule a time to reboot the switch, use the following command:

```
reboot time <date> <time>
```

Where `date` is the date and `time` is the time (using a 24-hour clock format) when the switch will be rebooted. The values use the following format:

```
mm dd yyyy hh mm ss
```



NOTE

When you configure a timed reboot of the switch, use the `show switch` command to see the scheduled time.

To reboot the switch immediately, use the following command:

```
reboot
```

If you do not specify a reboot time, the reboot occurs immediately following the command, and any previously scheduled reboots are cancelled. To cancel a previously scheduled reboot, use the `cancel` option.

On SummitStack only. The `reboot` command reboots the active topology and can be run from the master node only. The `reboot stack-topology` command reboots the entire stack topology and can be run on any node. Use the `reboot stack-topology as-standby` to eliminate the dual master condition manually.

Rebooting the Management Module—Modular Switches Only

To reboot a management module in a specific slot, rather than rebooting the switch, use the following command:

```
reboot {time <month> <day> <year> <hour> <min> <sec>} {cancel} {msm <slot_id>}
```

With the additional options available:

- `slot_id`— Specifies the slot where the module is installed
- `msm-a`— Specifies the MSM module installed in slot A
- `msm-b`— Specifies the MSM module installed in slot B



NOTE

When you configure a timed reboot of an MSM/MM, use the `show switch` command to see the scheduled time.

For more information about all of the options available with the `reboot` command, see the *ExtremeXOS Command Reference Guide*.

Rebooting a Node in a SummitStack

To reboot a single node in the SummitStack, use the following command:

```
reboot {[time <mon> <day> <year> <hour> <min> <sec>] | cancel} {slot <slotnumber> | node-address <node-address>}
```

The `reboot slot` command works only on the active master node for other slots, and on an active non-master node for its own slot. The `reboot node-address` command reboots the specified node from any node.

Understanding Hitless Upgrade—Modular Switches Only

Hitless upgrade is a mechanism that allows you to upgrade the ExtremeXOS software running on the MSMs without taking the switch out of service. Some additional benefits of using hitless upgrade include:

- Minimizing network downtime
- Reducing the amount of traffic lost

Although any method of upgrading software can have an impact on network operation, including interrupting Layer 2 network operation, performing a hitless upgrade can decrease that impact.

You must have two MSMs installed in your switch to perform a hitless upgrade. With two MSMs installed in the switch, one assumes the role of primary and the other assumes the role of backup. The primary MSM provides all of the switch management functions including bringing up and programming the I/O modules, running the bridging and routing protocols, and configuring the switch. The primary MSM also synchronizes its configurations with the backup MSM which allows the backup to take over the management functions of the primary.

**NOTE**

The software on the I/O modules is not updated during a hitless upgrade, only the software on the MSMs. The I/O module software is updated when the switch reboots or when a disabled slot is enabled.

**NOTE**

If you download an image to the backup MSM, the image passes through the primary MSM before the image is downloaded to the backup MSM.

Understanding the I/O Version Number

BlackDiamond 8800 Series Switches Only

Each ExtremeXOS image comes bundled with an I/O module image and contains a unique upgrade compatibility version number, known as the I/O version number. This number determines the relationship between the I/O module image and the ExtremeXOS image and their support for hitless upgrade. The I/O version number contains build information for each version of ExtremeXOS, including the major and minor version numbers, and the I/O version number.

Extreme Networks generates the I/O version number, and this number increases over time. Any modifications to the I/O module image after a major software release changes the I/O version number. For example, if Extreme Networks delivers a patch or service release that modifies the I/O module image, the I/O version number increases.

When you initiate a hitless upgrade by using the `run msm-failover {force}` command on the backup MSM, it checks the I/O version number to determine if a hitless upgrade is possible. Depending on the currently running software, the switch performs, allows, or denies a hitless upgrade. The following describes the switch behavior:

- If the new ExtremeXOS image supports hitless upgrade and is compatible with the current running I/O module image, you can perform a hitless upgrade.
- If the new ExtremeXOS image supports hitless upgrade, is compatible with the current running I/O image but with a degradation of functionality, you can perform a hitless upgrade with caveats. The switch warns you that the upgrade is hitless; however, the downloaded software may result in a loss of new functionality. You can either continue the upgrade with the modified functionality or cancel the action.

To prevent a loss in functionality, schedule time to take the switch offline to perform the upgrade; do not upgrade the software using hitless upgrade.

- If the new ExtremeXOS image supports hitless upgrade but is not compatible with the current running I/O module image (the I/O version numbers do not match), you cannot perform a hitless upgrade.

The switch warns you that the upgrade may not be hitless. You can either continue the upgrade or cancel the action. If you continue the upgrade, the primary MSM downloads the new image to the I/O module and reboots.

The following is a sample of the warning message displayed by the switch:

```
WARNING: The other MSM operates with a different version of I/O module image.  
If you continue with the MSM failover, all I/O modules will be reset.
```

```
Are you sure you want to failover? (y/n)
```

Performing a Hitless Upgrade

The steps described in this section assume the following:

- You have received the new software image from Extreme Networks, and the image is on either a TFTP server, compact flash card, or USB 2.0 storage device. For more information, see [“Downloading a New Image” on page 1477](#).
- You are running a version of ExtremeXOS that supports hitless upgrade.

Review the following list to confirm that your system supports hitless upgrade:

- BlackDiamond 8800 series switches—Both MSMs are running at least ExtremeXOS 11.4 and adhere to the minimum level of ExtremeXOS software required for all modules installed in the switch.
- BlackDiamond 10808 switches—Both MSMs are running ExtremeXOS 11.1 or later. Earlier versions of ExtremeXOS do not support hitless upgrade.
- BlackDiamond 12804 switches—Both MSMs are running ExtremeXOS 11.4 or later.



NOTE

Hitless upgrade for network login is not supported when upgrading from an earlier version of ExtremeXOS software to ExtremeXOS 12.1 or later. If a hitless upgrade is required, you must globally disable network login and re-enable it when the upgrade is complete.

Hitless Upgrade Caveats for BlackDiamond 8800 Series Switches Only

The following is a summary of hitless upgrade caveats for BlackDiamond 8800 series switches only:

- If you attempt a hitless upgrade between major releases, the switch warns you that the upgrade is not hitless. You can either continue the upgrade or cancel the action. If you continue the upgrade, the primary MSM downloads the new image to the I/O module and reboots them.

**NOTE**

If you are upgrading to a newer MSM module on a BlackDiamond 8800 series switch, you must insure you are running a version of ExtremeXOS that supports the newer MSM module before it is installed in the switch.

Hitless upgrade is not supported between major releases, for instance ExtremeXOS 11.x and 12.x. Do not attempt to perform a hitless upgrade. For information about installing an image without using hitless upgrade, see [“Installing a Core Image” on page 1480](#).

Summary of Tasks

To perform a hitless upgrade to install and upgrade the ExtremeXOS software on your system:

- 1 View the current switch information.
 - Determine your selected and booted image partitions.
 - Verify which MSM is the primary and which is the backup.
 - Confirm that the MSMs are synchronized.
- 2 Select the alternate partition to download the image to (and the partition to boot from after installing the image). Download and install the new ExtremeXOS core image on the backup MSM. Reboot this MSM.
- 3 Verify that the backup MSM comes up correctly and that the MSMs are synchronized.
- 4 Initiate failover from the primary MSM to the backup MSM. The backup MSM now becomes the new primary MSM.
- 5 Verify that the MSMs come up correctly and that they are synchronized.
- 6 Download and install the new ExtremeXOS core image on the original primary MSM (new backup MSM). Reboot this MSM.
- 7 Verify that the new backup MSM comes up correctly and that the MSMs are synchronized.
- 8 Initiate failover from the new primary MSM to the new backup MSM.
This optional step restores the switch to the original primary and backup MSM.
- 9 Confirm that the failover is successful.
This optional step confirms which MSM is the primary or the backup.

**NOTE**

Beginning with ExtremeXOS 12.1, you must install the ExtremeXOS core image (.xos file) on the alternate partition. Should you attempt to install the image to the active partition, the following error message is displayed. “Error: Image can only be installed to the non-active partition.” An ExtremeXOS modular software package (.xmod file) can still be downloaded and installed on either the active or alternate partition.

Detailed Steps

To perform a hitless upgrade to install and upgrade the ExtremeXOS software on your system:

- 1 View current switch information using the following command:

```
show switch
```

Determine your selected and booted partition, verify which MSM is the primary and which is the backup, and confirm that the MSMs are synchronized.

Output from this command indicates, for each MSM, the selected and booted images and if they are in the primary or the secondary partition. The selected image partition indicates which image will be used at the next reboot. The booted image partition indicates the image used at the last reboot. It is the active partition.

The current state indicates which MSM is the primary (displayed as MASTER), which MSM is the backup (displayed as BACKUP), and if the backup MSM is synchronized with the primary MSM (displayed as In Sync).

- 2 Select the alternate partition to download the image to and download and install the new ExtremeXOS core image on the backup MSM using the following command:

```
download image [[<hostname> | <ipaddress>] <filename> {{vr} <vrname>} | memorycard
<filename>] {<partition>} {msm <slotid>}
```

**NOTE**

If the backup MSM is installed in slot B, specify msm B. If the backup MSM is installed in slot A, specify msm A.

- If you have an expired service contract and attempt to download a new image, you see the following message:

```
Service contract expired, please renew it to be able to download the new
software image.
```

If you see this message, you must renew your service contract to proceed.

- When you have a current service contract, before the download begins the switch asks if you want to install the image immediately after the download is finished.
- After you download and install the software image on the alternate partition, you must reboot the MSM manually before you proceed. To reboot the switch, use the following command:

```
reboot {time <month> <day> <year> <hour> <min> <sec>} {cancel} {msm <slot_id>}
{slot <slot-number> | node-address <node-address> | stack-topology {as-standby}
}
```

Reboot only the backup MSM so the switch continues to forward traffic.

- If you install the image at a later time, use the following command to install the software:

```
install image <fname> {<partition>} {msm <slotid>} {reboot}
```

- 3 Verify that the backup MSM comes up correctly and that the MSMs are synchronized using the following command:

```
show switch
```

The current state indicates which MSM is the primary (displayed as MASTER), which MSM is the backup (displayed as BACKUP), and if the backup MSM is synchronized with the primary MSM (displayed as In Sync).

- 4 Initiate failover from the primary MSM to the backup MSM using the following command:

```
run msm-failover
```

When you failover from the primary MSM to the backup MSM, the backup becomes the new primary, runs the software on its active partition, and provides all of the switch management functions.

If you have a BlackDiamond 8800 series switch and the new ExtremeXOS image supports hitless upgrade but is not compatible with the current running I/O module image (the I/O version numbers do not match), you cannot perform a hitless upgrade.

The switch displays a warning message similar to the following:

```
WARNING: The other MSM operates with a different version of I/O module image.
If you continue with the MSM failover, all I/O modules will be reset.
```

```
Are you sure you want to failover? (y/n)
```

You can either continue the upgrade or cancel the action. If you continue the upgrade, the primary MSM downloads the new image to the I/O module and reboots.

- 5 Verify that the backup MSM comes up correctly and that the MSMs are synchronized using the following command:

```
show switch
```

The current state indicates which MSM is the primary (displayed as MASTER), which MSM is the backup (displayed as BACKUP), and if the backup MSM is synchronized with the primary MSM (displayed as In Sync).

- 6 Select the alternate partition to download the image to and download and install the new ExtremeXOS core image on the new backup MSM (this was the original primary MSM) using the following command:

```
download image [[<hostname> | <ipaddress>] <filename> {{vr} <vrname>} | memorycard
<filename>] {<partition>} {msm <slotid>}
```



NOTE

If the new backup MSM is installed in slot A, specify msm A. If the new backup MSM is installed in slot B, specify msm B.

- Before the download begins, the switch asks if you want to install the image immediately after the download is finished.
- After you download and install the software image on the alternate partition, you need to reboot the MSM manually before you proceed. To reboot the switch, use the following command:

```
reboot {time <month> <day> <year> <hour> <min> <sec>} {cancel} {msm <slot_id>}
{slot <slot-number> | node-address <node-address> | stack-topology {as-standby}}
}
```

Reboot only the backup MSM so the switch continues to forward traffic.

- If you install the image at a later time, use the following command to install the software:

```
install image <fname> {<partition>} {msm <slotid>} {reboot}
```

- 7 Verify that the new backup MSM comes up correctly and that the MSMs are synchronized using the following command:

```
show switch
```

The current state indicates which MSM is the primary (displayed as MASTER), which MSM is the backup (displayed as BACKUP), and if the backup MSM is synchronized with the primary MSM (displayed as In Sync).

- 8 Optionally, initiate failover from the new primary MSM to the new backup MSM using the following command:

```
run msm-failover
```

When you failover from the new primary MSM to the new backup MSM, this optional step restores the switch to the original primary and backup MSM.

- 9 Optionally, confirm that the failover is successful by checking the current state of the MSMs using the following command:

```
show switch
```

You can also perform a hitless upgrade on ExtremeXOS modular software packages (.xmod files). To perform a hitless upgrade of a software package, you must install the core software image first, and the version number of the modular software package must match the version number of the core image that it will be running with.

For more detailed information about modular software packages, see “[Installing a Modular Software Package](#)” on page 1483. To perform a hitless upgrade, follow the steps described in the previous section, “[Performing a Hitless Upgrade](#).”

Hitless Upgrade Examples

This section provides an example to perform a hitless upgrade on the BlackDiamond 8800 series switches.



NOTE

Before you begin, make sure you are running a version of ExtremeXOS that supports hitless upgrade. For more information, see the list [on page 1488](#).

Examples on the BlackDiamond 8800 Series Switches

Using the assumptions described below, the following examples perform a hitless upgrade for a core software image on BlackDiamond 8800 series switches:

- You have received the new software image from Extreme Networks named *bd8800-11.4.0.12.xos*.
- You do not know your selected or booted partitions.
- You are currently using the *primary* partition.
- The image is on a TFTP server named *tftphost*.
- You are installing the new image immediately after download.
- The MSM installed in slot A is the primary.
- The MSM installed in slot B is the backup.
- You are running ExtremeXOS 11.4 or later on both MSMs.

Performing a Hitless Upgrade on the Alternate Partition. The following example shows the commands necessary to perform a hitless upgrade on the alternate partition. In this example, the secondary partition is the inactive partition:

```
show switch
download image tftphost bd8800-11.4.0.12.xos secondary
show switch
reboot msm B
show switch
run msm-failover
show switch
```

After executing these commands, MSM B will be the master, and the secondary partition will be the active partition for both MSMs. The previously running software will reside on the inactive partition (now, the primary partition).

Configuration Changes

This section describes the following topics:

- [Overview on page 1493](#)
- [Viewing a Configuration on page 1494](#)
- [Restoring Factory Defaults on page 1494](#)
- [Uploading ASCII-Formatted Configuration Files on page 1495](#)

Overview

The configuration is the customized set of parameters that you have selected to run on the switch. As you make configuration changes, the new settings are stored in run-time memory. Settings that are stored in run-time memory are not retained by the switch when the switch is rebooted. To retain the settings and have them loaded when you reboot the switch, you must save the configuration to nonvolatile storage.

The switch can store multiple user-defined configuration files, each with its own filename. By default, the switch has two prenamed configurations: a primary and a secondary configuration. When you save configuration changes, you can select to which configuration you want the changes saved or you can save the changes to a new configuration file. If you do not specify a filename, the changes are saved to the configuration file currently in use. Or if you have never saved any configurations, you are asked to save your changes to the primary configuration.



NOTE

Configuration files have a `.cfg` file extension. When you enter the name of the file in the CLI, the system automatically adds the `.cfg` file extension.

If you have made a mistake or you must revert to the configuration as it was before you started making changes, you can tell the switch to use the backup configuration on the next reboot.

Each filename must be unique and can be up to 32 characters long. Filenames are also case sensitive. For information on filename restrictions, refer to the specific command in the *ExtremeXOS Command Reference Guide*.

To save the configuration, use the following command:

```
save configuration {primary | secondary | <existing-config> | <new-config>}
```

Where the following is true:

- `primary`—Specifies the primary saved configuration
- `secondary`—Specifies the secondary saved configuration

- `existing-config`—Specifies an existing user-defined configuration (displays a list of available user-defined configuration files)
- `new-config`—Specifies a new user-defined configuration

You are then prompted to save the changes. Enter `y` to save the changes or `n` to cancel the process.

To use the configuration, use the following command:

```
use configuration [primary | secondary | <file_name>]
```

Where the following is true:

- `primary`—Specifies the primary saved configuration
- `secondary`—Specifies the secondary saved configuration
- `file_name`—Specifies an existing user-defined configuration (displays a list of available user-defined configuration files)

The configuration takes effect on the next reboot.



NOTE

If the switch is rebooted while in the middle of saving a configuration, the switch boots to factory default settings if the previously saved configuration file is overwritten. The configuration that is not in the process of being saved is unaffected.

Viewing a Configuration

You can view the current configuration on the switch by using the following command:

```
show configuration {<module-name>} {detail}
```

You can also view just that portion of the configuration that applies to a particular module (for example, SNMP) by using the `module-name` parameter.

Beginning with ExtremeXOS 12.1, when you specify `show configuration only`, the switch displays configuration information for each of the switch modules excluding the default data.

You can send output from the `show configuration {<module-name>} {detail}` command to the Extreme Networks Technical Support department for problem-solving purposes. The output maintains the command line interface (CLI) format of the current configuration on the switch.

Restoring Factory Defaults

The following two procedures restore the switch to factory defaults and reboot the switch. Use the first procedure when you can log in to the switch and issue a CLI command and the second when you cannot.

When you can log in to the switch, use the following command:

```
unconfigure switch
```

This command resets most of the configuration, with the exception of user-configured user accounts and passwords, the date, and the time. On SummitStack, the command also preserves stacking-specific parameters so the stack can be formed after reboot.

To unset the currently selected configuration image, reset all switch parameters, and reboot the switch, use the following command:

```
unconfigure switch all
```

If you cannot log in because the switch is in a continuous booting loop, use the following procedure:

- 1 Reboot the switch while pressing the space bar. This puts the switch in Bootstrap mode.
- 2 From the Bootstrap prompt, type **boot** and then press **Enter** and press the spacebar. This puts the switch in BootROM mode.
- 3 From the BootROM prompt, type **config none**. The following appears:
Configuration selected: none
- 4 From the BootROM prompt, type **reboot**. The switch reboots and restores the factory defaults.

Uploading ASCII-Formatted Configuration Files

You can upload your current configuration in ASCII format to a TFTP server. The uploaded ASCII file retains the CLI format and allows you do the following:

- View and modify the configuration using a text editor, and later download a copy of the file to the same switch or to one or more different switches.
- Send a copy of the configuration file to Extreme Networks Technical Support for problem-solving purposes.

Summary of Tasks

The following summary describes only the CLI involved to transfer the configuration and load it on the switch; it is assumed that you know how to modify the configuration file with a text editor. As previously described, to use these commands, use the .xsf file extension. These steps are not applicable to configurations that use the .cfg file extension.

To work with an ASCII-formatted configuration file, complete the following tasks:

- 1 Upload the configuration to a network TFTP server using the following command:

```
upload configuration [<hostname> | <ipaddress>] <filename> {vr <vr-name>}
```

After the configuration file is on the TFTP server, use a text editor to enter the desired changes, and rename the file if necessary so it has the .xsf extension.

- 2 Download the configuration from the TFTP server to the switch using one of the following commands:

```
tftp [<host-name> | <ip-address>] -g -r <remote-file>
```

```
tftp get [<host-name> | <ip-address>] <remote-file>
```

- 3 Verify the configuration file is on the switch using the following command:

```
ls
```

- 4 Load and restore the new configuration file on the switch using the following command:

```
load script <filename> {arg1} {arg2} ... {arg9}
```

- 5 Save the configuration to the configuration database so the switch can reapply the configuration after switch reboot using the following command:

```
save configuration {primary | secondary | <existing-config> | <new-config>}
```

When you save the configuration file, the switch automatically adds the .cfg file extension to the filename. This saves the ASCII configuration as an XML-based configuration file.

**NOTE**

Configuration files are forward compatible only and not backward compatible. That is, configuration files created in a newer release, such as ExtremeXOS 12.4, might contain commands that do not work properly in an older release, such as ExtremeXOS 12.1.

Uploading the ASCII Configuration File To a TFTP Server

To upload the current switch configuration as an ASCII-based file to the TFTP server, use the `upload configuration` command and save the configuration with the `.xsf` file extension.

For example, to transfer the current switch configuration as an ASCII-based file named `meg_upload_config1.xsf` to the TFTP server with an IP address of `10.10.10.10`, do the following:

```
upload configuration 10.10.10.10 meg_upload_config1.xsf
```

If you successfully upload the configuration to the TFTP server, the switch displays a message similar to the following:

```
Uploading meg_upload_config1.xsf to 10.10.10.10 ... done!
```

Downloading the ASCII Configuration File to the Switch

To download the configuration from the TFTP server to the switch, use the `tftp` or `tftp get` command. For example, to retrieve the configuration file named `meg-upload_config1.xsf` from a TFTP server with an IP address of `10.10.10.10`, you can use one of the following commands:

```
tftp 10.10.10.10 -g -r meg_upload_config1.xsf
tftp get 10.10.10.10 meg_upload_config1.xsf
```

If you successfully download the configuration to the switch, the switch displays a message similar to the following:

```
Downloading meg_upload_config1.xsf to switch... done!
```

Verifying that the ASCII Configuration File is on the Switch

To confirm that the ASCII configuration file is on the switch, use the `ls` command. The file with an `.xsf` extension is the ASCII configuration.

The following sample output contains an ASCII configuration file:

```
-rw-r--r--  1 root      0           98362 Nov  2 13:53 Nov022005.cfg
-rw-r--r--  1 root      0          117136 Dec 12 12:56 ridgeline.cfg
-rw-r--r--  1 root      0             68 Oct 26 11:17 mcastgroup.pol
-rw-r--r--  1 root      0           21203 Dec 13 15:40 meg_upload_config1.xsf
-rw-r--r--  1 root      0          119521 Dec  6 14:35 primary.cfg
-rw-r--r--  1 root      0           96931 Nov 11 11:01 primary_11_11_05.cfg
-rw-r--r--  1 root      0           92692 Jul 19 16:42 secondary.cfg
```

Loading the ASCII Configuration File

After downloading the configuration file, you must load the new configuration on the switch. To load and restore the ASCII configuration file, use the `load script <filename> {arg1} {arg2} ...`

`{arg9}` command. After issuing this command, the ASCII configuration quickly scrolls across the screen.

The following is an example of the type of information displayed when loading the ASCII configuration file:

```
script.meg_upload_config1.xsf.389 # enable snmp access
script.meg_upload_config1.xsf.390 # enable snmp traps
script.meg_upload_config1.xsf.391 # configure mstp region purple
script.meg_upload_config1.xsf.392 # configure mstp revision 3
script.meg_upload_config1.xsf.393 # configure mstp format 0
script.meg_upload_config1.xsf.394 # create stpd s0
```

Instead of entering each command individually, the script runs and loads the CLI on the switch.

Saving the Configuration

After you load the configuration, save it to the configuration database for use by the switch. This allows the switch to reapply the configuration after a switch reboot. To save the configuration, use the `save configuration {primary | secondary | <existing-config> | <new-config>}` command.

When you save the configuration file, the switch automatically adds the `.cfg` file extension to the filename. This saves the ASCII configuration as an XML-based configuration file.

You can use any name for the configuration. For example, after loading the file `meg_upload_config1.xsf`, you need to save it to the switch. To save the configuration as `configuration1.cfg`, use the following command:

```
save configuration configuration1
```

Using Autoconfigure and Autoexecute Files

Two features allow you automatically execute scripts that can manage the switch configuration.

Autoconfigure: Configuration commands placed in the `default.xsf` file are executed by the switch as it comes up and is unable to find its usual configuration file or if the switch is unconfigured or if the configuration file cannot be determined due to a corrupt NVRAM. This returns the switch to some basic configuration. When `default.xsf` is executed, the `show switch` command shows `default.xsf` as the booted configuration file.

The `default.xsf` file can have any CLI commands as long as they are all executed within 500 seconds. The script is aborted when the commands are not executed within that time. When the file is loaded, the results can be seen by executing the `show script output default` command.

Autoexecute: Configuration commands placed in the `autoexec.xsf` file are executed after a switch loads its configuration. The file is not executed when a `default.xsf` file has been executed. Use the file to execute commands after a switch is up and running and also to revert changes made to the configuration by UPM scripts that run persistent commands. The commands must be executed within 500 seconds or the script execution is aborted.

When an `autoexec.xsf` file is executed, the results can be seen by executing the `show script output autoexec` command.

Using TFTP to Upload the Configuration

You can upload the current configuration to a Trivial File Transfer Protocol (TFTP) server on your network. Using TFTP, the uploaded configuration file retains your system configuration and is saved in Extensible Markup Language (XML) format. This allows you to send a copy of the configuration file to the Extreme Networks Technical Support department for problem-solving purposes.

To view your current switch configuration, use the `show configuration {<module-name>} {detail}` command available on your switch. Do not use a text editor to view or modify your XML-based switch configuration files.

To view your current switch configuration in ASCII-format, see [“Uploading ASCII-Formatted Configuration Files” on page 1495](#) for more information about uploading and downloading ASCII-formatted configuration files.

For more information about TFTP, see [“Using the Trivial File Transfer Protocol” on page 79](#).

To upload the configuration from the switch to a TFTP server, you can use either the `tftp` or the `tftp put` command:

- `tftp [<host-name> | <ip-address>] -p -l <local-file> {-r <remote-file>}`

Where the following is true:

- `host-name`—Specifies the host name of the TFTP server
- `ip-address`—Specifies the IP address of the TFTP server
- `-p`—Puts the specified file from the local host and copies it to the TFTP server
- `-l <local-file>`—Specifies the name of the configuration file that you want to save to the TFTP server
- `-r <remote-file>`—Specifies the name of the configuration file on the TFTP server

- `tftp put [<host-name> | <ip-address>] <local-file> {<remote-file>}`

Where the following is true:

- `put`—Puts the specified file from the local host and copies it to the TFTP server
- `host-name`—Specifies the host name of the TFTP server
- `ip-address`—Specifies the IP address of the TFTP server
- `<local-file>`—Specifies the name of the configuration file that you want to save to the TFTP server
- `<remote-file>`—Specifies the name of the configuration file on the TFTP server

If you upload a configuration file and see the following message:

```
Error: No such file or directory
```

Check to make sure that you entered the filename correctly, including the `.cfg` extension, and that you entered the correct host name or IP address for the TFTP server.

If your upload is successful, the switch displays a message similar to the following:

```
Uploading megtest1.cfg to TFTPHost ... done!
```

You can also upload the current configuration in ASCII format from the switch to a TFTP server on your network. For more information, see [“Uploading ASCII-Formatted Configuration Files” on page 1495](#).

Using TFTP to Download the Configuration

You can download previously saved XML formatted XOS configuration files from a TFTP host to the switch to modify the switch configuration. Do not use a text editor to view or modify your switch configuration files; modify your switch configurations directly in the CLI.

To view your current switch configuration in ASCII-format, see [“Uploading ASCII-Formatted Configuration Files” on page 1495](#) for more information about uploading and downloading ASCII-formatted configuration files.

For more information about TFTP, see [“Using the Trivial File Transfer Protocol” on page 79](#).

To download the configuration from a TFTP host to the switch, you can use either the `tftp` or the `tftp get` command:

- `tftp` [`<host-name>` | `<ip-address>`] `-g -r <remote-file>` [`-l <local-file>`]

Where the following is true:

- `host-name`—Is the host name of the TFTP server
- `ip-address`—Is the IP address of the TFTP server
- `-g`—Gets the specified file from the TFTP server and copies it to the local host
- `-r <remote-file>`—Specifies the name of the configuration file that you want to retrieve from the TFTP server
- `-l <local-file>`—Specifies the name of the configuration file on the switch

- `tftp get` [`host-name>` | `<ip-address>`] `<remote-file>` [`<local-file>`] [`{force-overwrite}`]

Where the following is true:

- `get`—Gets the specified file from the TFTP server and copies it to the local host
- `host-name`—Is the host name of the TFTP server
- `ip-address`—Is the IP address of the TFTP server
- `<remote_file>`—Specifies the name of the configuration file that you want to retrieve from the TFTP server
- `<local-file>`—Specifies the name of the configuration file on the switch
- `force-overwrite`—Specifies the switch to automatically overwrite an existing file



NOTE

By default, if you transfer a file with a name that already exists on the system, the switch prompts you to overwrite the existing file. For more information, see the `tftp get` command in the ExtremeXOS Command Reference Guide.

If you download a configuration file and see the following message:

```
Error: Transfer timed out
```

Make sure that you entered the filename correctly, including the `.cfg` extension, and that you entered the correct host name or IP address for the TFTP server.

If your download is successful, the switch displays a message similar to the following:

```
Downloading megtest2.cfg to switch... done!
```

Configurations are downloaded and saved into the switch nonvolatile memory. The configuration is applied after you reboot the switch.

If the configuration currently running in the switch does not match the configuration that the switch used when it originally booted, an asterisk (*) appears before the command line prompt when using the CLI.

You can also download the current configuration in ASCII format from a TFTP server on your network to the switch. For more information, see [“Uploading ASCII-Formatted Configuration Files” on page 1495](#).

Synchronizing Nodes—Modular Switches and SummitStack Only

Before synchronizing nodes on a modular chassis or nodes on a SummitStack, review the following list to confirm that your platform and both installed MSMs/MMs are running software that supports the `synchronize` command:

- BlackDiamond 10808 switch—Both MSMs are running ExtremeXOS 11.0 or later.
- BlackDiamond 8800 series switches with a mix of BlackDiamond 8000 a-, c-, e-, xl-, and xm-series modules installed—Both MSMs are running ExtremeXOS 11.5 or later.
- SummitStack—all nodes are active nodes and running ExtremeXOS 12.0 or later.
- BlackDiamond 12804 switch—Both MSMs are running ExtremeXOS 11.4 or later.

On a dual MSM system or a SummitStack with redundancy, you can take the primary node configurations and images and replicate them on the backup node using the following command:

```
synchronize
```



CAUTION

During a synchronization, on a modular chassis, half of the switch fabric is lost. On a SummitStack, the active stack will briefly alternate between a ring and daisy-chain topology. When the primary node finishes replicating its configurations and images to the backup node, the full switch fabric or the stack ring is restored.

In addition to replicating the configuration settings and images, this command also replicates which configuration or image the node should use on subsequent reboots. This command does not replicate the run-time configuration. You must use the `save configuration` command to store the run-time configuration first.

On a SummitStack, you can synchronize an active node in the stack with the master node using the following command:

```
synchronize {slot <slotid>}
```

Additional Behavior on the BlackDiamond 8800 Series Switches Only

On the BlackDiamond 8800 series switches, the I/O ports on the backup MSM go down when you synchronize the MSMs. When the primary MSM finishes replicating its configurations and images to the backup MSM, the I/O ports on the backup MSM come back up.

Automatic Synchronization of Configuration Files

On a dual MSM/MM (node) modular chassis or on a SummitStack where redundancy is in use, ExtremeXOS automatically synchronizes all of the configuration files from the primary node to the backup node if the switch detects that the backup node's configuration file contents are different from the primary node. You do not configure this behavior.

The switch deletes the old configuration files on the backup node only upon a successful file synchronization. If an error occurs, the switch does not delete the old configuration files on the backup node. For example, if you install a backup node that contains different configuration files from the primary node, the old configuration files are deleted after a successful bootup of the backup node.

To see a complete listing of the configuration files on your system, use the `ls` command.

For more detailed information, see [“Replicating Data Between Nodes” on page 83](#).

Accessing the Bootloader

The Bootloader of the switch initializes certain important switch variables during the boot process. In the event the switch does not boot properly, some boot option functions can be accessed through the Bootloader.

Interaction with the Bootloader is required only under special circumstances and should be done only under the direction of Extreme Networks Customer Support. The necessity of using these functions implies a nonstandard problem which requires the assistance of Extreme Networks Customer Support.

To access the Bootloader menu:

- 1 Attach a serial cable to the console port of the switch.
- 2 Attach the other end of the serial cable to a properly configured terminal or terminal emulator, power cycle the switch, and press the spacebar key on the keyboard of the terminal during the bootup process.



NOTE

On the BlackDiamond X8 series switches, press and hold the spacebar key to enter the bootROM (actually a BIOS) as soon as you see `CF card tested OK` on the screen.

On a BlackDiamond 10808 switch, access the Bootloader by pressing the spacebar key immediately after a power cycle of the MSM to get into the Bootloader application.

On BlackDiamond 8800 series switches, when you see the BootROM banner, press the spacebar key to get into the Bootloader application.

On Summit family switches, when you see the Bootloader banner, press the spacebar key to get into the Bootloader application.

As soon as you see the `BOOTLOADER>` prompt (BlackDiamond 10808 switches or Summit family switches) or the `bootRom ->` prompt (BlackDiamond X8, 8800 series switches), release the spacebar. You can issue a series of commands to:

- View the installed images.
- Select the image to boot from.

- Select the configuration to use.
- Load a recovery image over the management port.
- Load a recovery image over the serial port (BlackDiamond 10808 switch only).

To see a list of available commands or additional information about a specific command, enter `h` or type `help`.

The following describes some ways that you can use the Bootloader:

- Viewing images—To display a list of installed images, use the `show image` command.
- Selecting an image—To change the image that the switch boots from in flash memory, use the `boot {image number}` command. If you specify `image number`, the specified image is booted. If you do not specify an image number, the default image is booted.
- Selecting a configuration—To select a different configuration from the one currently running, use the `config {alt | default | <filename> | none}` command. This command is useful if you experience a problem with the current configuration and there is an alternate configuration available.
 - `alt`—Specifies the alternate configuration file.
 - `default`—Specifies the default configuration file.
 - `filename`—Specifies a configuration filename.
 - `none`—Uses no configuration. This restores the switch to the default configuration. It may be helpful if a password has been forgotten.

To view the current configuration, use this command without any arguments.

To exit the Bootloader, use the `boot` command. Specifying `boot` runs the *currently selected* ExtremeXOS image.

Upgrading the BootROM

Summit Family Switches and SummitStack Only

The Summit family switches have a two-stage BootROM. The first stage, called `bootstrap`, does basic initialization of the switch processor and will load one of two second-stage bootloaders (called primary and secondary).

If the switch does not boot properly, both the `bootstrap` and the bootloader allows the user to access the boot options using the CLI.

If necessary, the bootloader can be updated after the switch has booted, using TFTP. You can upgrade the BootROM from a TFTP server on the network after the switch has booted and *only* when asked to do so by an Extreme Networks technical representative. For information about loading an image to a TFTP server and verifying which virtual router connects to your TFTP server, see [“Installing a Core Image” on page 1480](#).

To upgrade the BootROM, use the following command:

```
download bootrom [<ipaddress> | <hostname>] <filename> {{vr} <vrname>}
```

On a SummitStack, the BootROM can be centrally upgraded. Use the command above on the primary (Master) stack node to download a BootROM to all stacking nodes. To download to a single stacking node, you need to specify the slot parameter:

```
download bootrom [<ipaddress> | <hostname>] <filename> {slot <slot-number>} {{vr}
<vrname>}
```

**NOTE**

User-created VRs are supported only on the platforms listed for this feature in [Appendix A, “Feature License Requirements.”](#)

Accessing the Bootstrap CLI on the Summit Family Switches

The bootstrap CLI contains commands to support the selection of which bootloader to use. Interaction with the bootstrap is required only under special circumstances and should be done only under the direction of Extreme Networks Customer Support.

To access the bootstrap CLI:

- 1 Attach a serial cable to the serial console port of the switch.
- 2 Attach the other end of the serial cable to a properly configured terminal or terminal emulator.
- 3 Power cycle or reboot the switch.
- 4 As soon as you see the Bootstrap Banner, press the spacebar.

The `BOOTSTRAP>` prompt appears on the screen.

**NOTE**

If you accidentally enter the bootstrap CLI when you want to enter the Bootloader, at the `BOOTSTRAP>` prompt enter the `boot` command.

For detailed information and instructions on accessing the bootloader, see [“Accessing the Bootloader” on page 1501.](#)

Upgrading the Firmware

BlackDiamond 8800 Series Switches Only

Firmware images are bundled with ExtremeXOS software images. The bundled firmware images include

Microcontroller binaries, System FPGA images and BootROM images for the MM, I/O, and Fabric modules. ExtremeXOS automatically compares the existing firmware image flashed into the hardware with the firmware images bundled with the ExtremeXOS image when you download and install a new version of ExtremeXOS.

After a firmware image upgrade, messages are sent to the log. You can configure the switch to automatically upgrade the firmware when a different image is detected, or you can have the switch prompt you to confirm the upgrade process. To configure the switch’s behavior during a firmware upgrade, use the following command:

```
configure firmware [auto-install | install-on-demand]
```

Where the following is true:

- `auto-install`—Specifies ExtremeXOS to automatically upgrade the firmware if the software detects a newer firmware image is available. The switch does not prompt you to confirm the firmware upgrade.
- `on-demand`—Specifies the switch to prompt you to upgrade the firmware when ExtremeXOS determines that a newer firmware image is available. This is the default behavior.

You can use the `install firmware {force}` command to install the firmware bundled with the ExtremeXOS image. To install the new BootROM and firmware, wait until the `show slot` command indicates the MM, I/O, and Fabric modules are operational. When the modules are operational, use the `install firmware` command.

If the bundled firmware image is newer than the existing firmware image, the switch prompts you to confirm the upgrade.

- Enter `y` to upgrade the firmware.
- Enter `n` to cancel the firmware upgrade for the specified hardware and continue scanning for other hardware that needs to be upgraded.
- Enter `<cr>` to cancel the upgrade.

During the firmware upgrade, the switch also prompts you to save your configuration changes to the current, active configuration. Enter `y` to save your configuration changes to the current, active configuration. Enter `n` if you do not want to save your changes.

The new BootROM and firmware overwrite the older versions flashed into the hardware. A reboot is required to load the newly installed firmware. However, this does not need to be done immediately after a firmware upgrade. Use the `reboot` command to reboot the switch and activate the new BootROM and firmware. During the firmware upgrade, do not turn off or disrupt the power to the switch. If a power interruption occurs, the firmware may be corrupted and need to be recovered. ExtremeXOS automatically attempts to recover corrupted firmware; however, in some situations user intervention is required.

Power over Ethernet (PoE) firmware is always automatically upgraded or downgraded to match the operational ExtremeXOS code image. This configuration is not applicable to PoE firmware.

BlackDiamond 20800 Series Switches Only

Firmware images are bundled with ExtremeXOS software images. The firmware contains BootROM images, microcode, and FPGAs for the MM and I/O modules and the associated firmware images for the switch fabric (XFM) and power fan controllers (PFC).

The `install firmware` command has the following two options:

- To upgrade the embedded firmware on the respective hardware when the new image is a later version than the currently running image, use the default option. In this case, the ExtremeXOS software compares the existing firmware image in the hardware with the new firmware image bundled with the ExtremeXOS image.
- To forcefully install a new image without the ExtremeXOS software comparing the version of the existing image to the new image, use the `install firmware {force}` option. This can be used to downgrade the system to an earlier version.

Before using the either command option, it is advised that you check and ensure that all hardware is operational and check the version of the firmware images (reference the appropriate Software Release Notes) on various blades by using the following commands:

- `show switch`—displays an update on the overall switch status including system mode, time, MM mastership, and currently booted image.
- `show slot` to display the operational status of the MM and IOM slots. Ensure that all blades are in an “operational” state before installing firmware.
- `show version details` to check the versions of all firmware images on various blades.
- `show fans` to check the operational status and firmware levels.

After confirming that the status is operational, use the appropriate `install firmware` command option. To complete the installation process, the master MM interacts with all the I/O modules and fabric blades, the fan tray (through the PFCs), and the other MM blade PFCs and CFG uCs. If any error is detected during the upgrade of any blade, the ExtremeXOS software stops the installation process and leaves the remaining blades with the previous version.

When installation is complete, check the operational status and the firmware image versions again, using the commands described above as you did before installing the firmware.



NOTE

In versions prior to ExtremeXOS 12.4, when the `install firmware` command is issued, the following occurs:

- When the master MM CFG FW has an old version of uC firmware that is upgraded in this installation process, the master MM (MM-A) is swapped with the standby (MM-B). To change back to the previous status, issue the `run msm-failover` command on the current master MM (MM-B). MM-A then becomes master again, and the `show version detail` command displays the updated versions of the firmware.
- When the master MM CFG FW has a new version of uC firmware that does not require upgrading with this installation process, there is no change in mastership after installation, and the `show version detail` command displays the updated versions of the firmware.

BlackDiamond X8 Series Switches Only

Firmware images are bundled with ExtremeXOS software images. The bundled firmware images include microcontroller binaries, system FPGA images, and BootROM images for the MM, I/O, and Fabric modules. When you download and install a new version of ExtremeXOS, ExtremeXOS automatically compares the existing firmware image against the firmware images bundled with the ExtremeXOS image.

After a firmware image upgrade, messages are sent to the log. You can set the switch to automatically upgrade the firmware when a different image is detected or have the switch prompt you to confirm the upgrade. To set the switch’s behavior during a firmware upgrade, use the following command:

```
configure firmware [auto-install | install-on-demand]
```

- `auto-install`—Automatically upgrade the firmware if a newer firmware image is available. You are *not* prompted to confirm the firmware upgrade.
- `install-on-demand`—Prompts you to upgrade the firmware when a newer firmware image is available (default behavior).

To install the firmware bundled with the ExtremeXOS image, use the `install firmware {force}` command. To install the new BootROM and firmware, wait until the `show slot` command indicates the

MM, I/O and Fabric modules are operational. When the modules are operational, use the `install firmware {force}` command.

If the bundled firmware image is newer than the existing firmware image, the switch prompts you to confirm the upgrade.

- Type `y` to upgrade the firmware.
- Type `n` to cancel the firmware upgrade for the specified hardware, and continue scanning for other hardware that needs to be upgraded.
- Press [Enter] to cancel the upgrade.

During the firmware upgrade, the switch also prompts you to save your configuration changes to the current, active configuration. To save your configuration changes to the current, active configuration, type `y`. To discard your changes, type `n`.

The new BootROM and firmware overwrite the older versions. You must reboot the switch to load the newly installed firmware. However, you do *not* need to do this immediately after a firmware upgrade. Use the `reboot {time <month> <day> <year> <hour> <min> <sec>} {cancel} {msm <slot_id>} {slot <slot-number> | node-address <node-address> | stack-topology {as-standby} }` command to reboot the switch and activate the new BootROM and firmware. During the firmware upgrade, do not turn off or disrupt the power to the switch. If power is lost, the firmware may be corrupted and need to be recovered. ExtremeXOS automatically attempts to recover corrupted firmware; however, in some situations user intervention is required.

Displaying the BootROM and Firmware Versions

To display the BootROM (firmware) version on the switch and on all of the modules and PSU controllers installed in a modular switch, use the `show version` command.

The following is sample output from the Summit series switch:

```
Switch      : 800132-00-02 0512G00636 Rev 2.0 BootROM: 1.0.0.6      IMG: 11.4.0.15
XGM-2xn-1  :

Image       : ExtremeXOS version 11.4.0.15 v1140b15 by release-manager
              on Fri Dec 30 11:05:42 PST 2005
BootROM     : 1.0.0.6
```

The following is sample output from a BlackDiamond 10808 switch:

```
Chassis     : 804300-00-09 0438F-00850 Rev 9.0
Slot-1      : 804403-00-08 0405F-00063 Rev 8.0 BootROM: 1.3.0.0      IMG: 11.4.0.23
Slot-2      : 804406-00-02 0511F-00605 Rev 2.0
Slot-3      : 804406-00-02 0511F-00602 Rev 2.0
Slot-4      :
Slot-5      :
Slot-6      :
Slot-7      :
Slot-8      :
MSM-A       : 804301-00-09 0434F-00125 Rev 9.0 BootROM: 1.0.1.5      IMG: 11.4.0.25
MSM-B       : 804301-00-09 0437F-00026 Rev 9.0 BootROM: 1.0.1.5      IMG: 11.4.0.23
PSUCTRL-1   : 704025-00-06 0438F-00089 Rev 6.0 BootROM: 5.3
PSUCTRL-2   : 704025-00-06 0438F-00096 Rev 6.0 BootROM: 5.3

Image       : ExtremeXOS version 11.4.0.25 v1140b25 by release-manager
              on Fri Feb 24 11:02:17 PST 2006
```

BootROM : 1.0.1.5

The following is sample output from a BlackDiamond X8 series switch:

BD-X8.8 # show version detail

```

Chassis      : 800427-00-00 000000000000 Rev 0.0
Slot-1       : 800439-00-00 000000000000 Rev 0.0 BootROM: 1.0.0.5   IMG: 15.1.0.23
FPGA : 0.0.32.0
Slot-2       : 800439-00-00 000000000000 Rev 0.0 BootROM: 1.0.0.5   IMG: 15.1.0.23
FPGA : 0.0.32.0
Slot-3       : 800439-00-00 000000000000 Rev 0.0 BootROM: 1.0.0.5   IMG: 15.1.0.23
FPGA : 0.0.32.0
Slot-4       : 800439-00-00 000000000000 Rev 0.0 BootROM: 1.0.0.5   IMG: 15.1.0.23
FPGA : 0.0.32.0
Slot-5       : 800439-00-00 000000000000 Rev 0.0 BootROM: 1.0.0.5   IMG: 15.1.0.23
FPGA : 0.0.32.0
Slot-6       : 800439-00-00 000000000000 Rev 0.0 BootROM: 1.0.0.5   IMG: 15.1.0.23
FPGA : 0.0.32.0
Slot-7       : 800439-00-00 000000000000 Rev 0.0 BootROM: 1.0.0.5   IMG: 15.1.0.23
FPGA : 0.0.32.0
Slot-8       : 800439-00-00 000000000000 Rev 0.0 BootROM: 1.0.0.5   IMG: 15.1.0.23
FPGA : 0.0.32.0
FM-1        : 800433-00-00 000000000000 Rev 0.0 BootROM: 1.0.0.5   IMG: 15.1.0.23
FPGA : 0.0.32.0
FM-2        : 800433-00-00 000000000000 Rev 0.0 BootROM: 1.0.0.5   IMG: 15.1.0.23
FPGA : 0.0.32.0
FM-3        : 800433-00-00 000000000000 Rev 0.0 BootROM: 1.0.0.5   IMG: 15.1.0.23
FPGA : 0.0.32.0
FM-4        : 800433-00-00 000000000000 Rev 0.0 BootROM: 1.0.0.5   IMG: 15.1.0.23
FPGA : 0.0.32.0
MM-A        : 800432-00-00 1130G-00826 Rev 0.0 BootROM: 1.0.0.2   IMG: 15.1.0.23
FPGA : 0.1.18.0
MM-B        :
PSUCTRL-1   : 450357-00-00 000000000000 Rev 0.0
PSUCTRL-2   : 450357-00-00 000000000000 Rev 0.0
FanTray-1   : 450350-00-00 000000000000 Rev 0.0 BootROM: 1.0.2.5
FanTray-2   : 450350-00-00 000000000000 Rev 0.0 BootROM: 1.0.2.5
FanTray-3   : 450350-00-00 000000000000 Rev 0.0 BootROM: 1.0.2.5
FanTray-4   : 450350-00-00 000000000000 Rev 0.0 BootROM: 1.0.2.5
FanTray-5   : 450350-00-00 000000000000 Rev 0.0 BootROM: 1.0.2.5
PSU-1       : H2500A2-EX 4300-00212 1109X-88834 Rev 1.0
PSU-2       : H2500A2-EX 4300-00212 1109X-88758 Rev 1.0
PSU-3       :
PSU-4       :
PSU-5       : H2500A2-EX 4300-00212 1109X-88787 Rev 1.0
PSU-6       : H2500A2-EX 4300-00212 1109X-88831 Rev 1.0
PSU-7       :
PSU-8       :
    
```

Image : ExtremeXOS version 15.1.0.23 v1510b23 by release-manager
on Fri Dec 16 12:05:18 EST 2011

BootROM : 1.0.0.2

Diagnostics : 1.8 (MM), 1.6 (I/O and FM)

The following is sample output from a BlackDiamond 8800 series switch:

```
Chassis      : 800129-00-02 04344-00039 Rev 2.0
Slot-1      : 800114-00-04 04364-00021 Rev 4.0 BootROM: 1.0.1.7      IMG: 11.4.0.23
Slot-2      : 800115-00-02 04344-00006 Rev 2.0 BootROM: 1.0.1.7      IMG: 11.4.0.23
Slot-3      : 800113-00-04 04354-00031 Rev 4.0 BootROM: 1.0.1.7      IMG: 11.4.0.23
Slot-4      :
Slot-5      : 800112-00-03 04334-00040 Rev 3.0 BootROM: 1.0.1.7      IMG: 11.4.0.23
Slot-6      : 800112-00-03 04334-00004 Rev 3.0 BootROM: 1.0.1.7      IMG: 11.4.0.23
Slot-7      :
Slot-8      :
Slot-9      :
Slot-10     :
MSM-A       : 800112-00-03 04334-00040 Rev 3.0 BootROM: 1.0.1.7      IMG: 11.4.0.23
MSM-B       : 800112-00-03 04334-00004 Rev 3.0 BootROM: 1.0.1.7      IMG: 11.4.0.23
PSUCTRL-1   : 450117-00-01 04334-00021 Rev 1.0 BootROM: 2.13
PSUCTRL-2   : 450117-00-01 04334-00068 Rev 1.0 BootROM: 2.13

Image       : ExtremeXOS version 11.4.0.23 v1140b23 by release-manager
              on Thu Feb 16 12:47:41 PST 2006
BootROM     : 1.0.1.7
```

The following is sample output from a BlackDiamond 12804 switch:

```
Chassis      : 804023-00-09 06065-00549 Rev 9.0
Slot-1      : 804019-00-01 05234-00033 Rev 1.0 uC: 2.01 FPGA: 5.07
Slot-2      : 804019-00-02 05404-00055 Rev 2.0 uC: 2.01 FPGA: 5.07
Slot-5      : 804022-00-03 05474-00070 Rev 3.0 uC: 2.01 FPGA: 5.07
Slot-6      : 804019-00-01 05234-00026 Rev 1.0 uC: 2.01 FPGA: 5.07
MSM-A       : 804017-00-02 05394-00007 Rev 2.0 BootROM: 1.0.0.2      IMG: 11.4.0.25 uC:
2.01 FPGA: 3.1f
MSM-B       : 804017-00-02 05394-00011 Rev 2.0 BootROM: 1.0.0.2      IMG: 11.4.0.25 uC:
2.01
PSUCTRL-1   : 700087-00-07 06035-00673 Rev 7.0 BootROM: 2.13
PSUCTRL-2   : 700087-00-07 06035-00706 Rev 7.0 BootROM: 2.13

Image       : ExtremeXOS version 11.4.0.25 v1140b25 by release-manager
              on Fri Feb 24 10:48:51 PST 2006
BootROM     : 1.0.0.2
```

The following is sample output from a BlackDiamond 20808 switch:

```
BD-20808.2 # show version detail

Chassis      : 806000-00-09 0908H-00065 Rev 9.0
Slot-1      :
Slot-2      :
Slot-3      : 806010-00-09 09016-80003 Rev 9.0 BootROM: 0.0.3.5      IMG: 12.3.2.5 uC:
2.2
              FPGA: [A]: 0.0.35 [P]: 0.0.6 [W1]: 0.0.d [W2]: 0.0.d
                  [T1]: 0.0.11
              NPU: [A]: c2 (240T) [B]: c2 (240T)
              TM: [A]: 2 [Dbg-A]: 0 [B]: 2 [Dbg-B]: 0
                  [Driver]: 2.512 [Application]: 1.300
Slot-4      :
Slot-5      : 806004-00-12 09086-80033 Rev 12.0 uC: 2.5
Slot-6      :
```

```

Slot-7      : 806010-00-09 09016-80019 Rev 9.0 BootROM: 0.0.3.5   IMG: 12.3.2.5   uC:
2.2
             FPGA: [A]: 0.0.35 [P]: 0.0.6 [W1]: 0.0.d [W2]: 0.0.d
               [T1]: 0.0.11
             NPU: [A]: c2 (240T) [B]: c2 (240T)
             TM: [A]: 2 [Dbg-A]: 0 [B]: 2 [Dbg-B]: 0
               [Driver]: 2.512 [Application]: 1.300

Slot-8      :
MM-A        : 806013-00-08 09016-80037 Rev 8.0 BootROM: 0.0.1.9   IMG: 12.3.2.5
uC: 2.2 FPGA S: 0.3.c

MM-B        : 806013-00-08 09076-80078 Rev 8.0 BootROM: 0.0.1.9   IMG: 12. 3.2.5
uC: 2.2

PSUCTRL-1   :                               Rev 2.2
PSUCTRL-2   :                               Rev 2.2
FABRIC-1    : 806001-00-05 09036-80117 Rev 5.0 uC: 2.2 F-1: 1.0 F-2: 1.0
FABRIC-2    : 806001-00-05 08516-80133 Rev 5.0 uC: 2.2 F-1: 1.0 F-2: 1.0
FABRIC-3    : 806001-00-05 09036-80037 Rev 5.0 uC: 2.2 F-1: 1.0 F-2: 1.0
FABRIC-4    : 806001-00-05 09036-80121 Rev 5.0 uC: 2.2 F-1: 1.0 F-2: 1.0
FABRIC-5    : 806001-00-05 08516-80161 Rev 5.0 uC: 2.2 F-1: 1.0 F-2: 1.0
PSU-1       :
PSU-2       :
PSU-3       : PS lugged-in CS2500A1-EX 0847X-80174 Rev 1.0
PSU-4       : PS lugged-in CS2500A1-EX 0847X-80153 Rev 1.0
PSU-5       : PS lugged-in CS2500A1-EX 0847X-80045 Rev 1.0

Image       : ExtremeXOS version 12.3.2.5 v1232b5 by release-manager
              on Tue Aug 25 00:00:38 PDT 2009
    
```




CNA Agent

The entire Converged Network Analyzer (CNA) software package consists of multiple parts. The Extreme Networks devices run only the CNA Agent. You must have the entire package; you cannot use the CNA Agent without the CNA software from Avaya Inc.[®]. The user interface is a combination of a Java applet hosted from the CNA Server and a command line interface (CLI). You configure and manage the CNA Agent using the CLI.



NOTE

Contact your Avaya representative to obtain the rest of the CNA software and the associated documentation.

If you are using Avaya CNA solutions, download a separate software module to add the CNA Agent to ExtremeXOS software; this software module runs on all platforms.



NOTE

You must download and install the SSH2 software module before downloading and installing the CNA Agent software module.

This appendix includes the following sections:

- [Overview on page 1511](#)
- [Downloading the CNA Agent Software Module on page 1512](#)
- [Running the Tests on page 1512](#)
- [Configuring the CNA Agent on page 1513](#)

Overview

The CNA Agent accepts requests (from the CNA Server) to run tests for measuring and verifying network performance, and the CNA Agent reports back the results to the CNA Server. The CNA Agent functions as a UDP service accepting authenticated requests from and returning test results to the CNA Server.

You download the CNA Agent software as a separate software module onto your device. If you do not have it already, you must also download the separate SSH2 software module, which contains SSL.

After you enable the software, the CNA Agent registers with the CNA Server and exchanges openSSL keys, using a 128-bit encryption key. All following communication between the CNA Agent and the CNA Server is encrypted.

The CNA Server communicates with the CNA Agent to request specific tests and to schedule those tests. The CNA Agent runs the requested tests and sends the results back to the CNA Server.

The CNA Agent can register with one CNA Server, talk to one CNA Server at a time, and respond to only one test request at a time. The other test requests are queued up.

The system sends messages to the syslog for each new connection, the status of that connection, received test requests, and reported test results. Also EMS messages are generated after successful registration.

Redundancy

The CNA Agent software offers resiliency and redundancy on the BlackDiamond 10808 switches, BlackDiamond 12800 series switches, the BlackDiamond 20800 series switches, SummitStack, and the BlackDiamond 8800 series switches. On systems with a primary and a backup node, the CNA Agent software fails over to the backup node when the primary node goes down. Also, the node restarts the CNA Agent software if the CNA Agent goes down or gets into a looped condition.

Downloading the CNA Agent Software Module

To use the CNA Agent functionality, you download the separate Extreme Networks software module (cna.xmod) following the instructions outlined in [Appendix B, “Software Upgrade and Boot Options.”](#)

Because the CNA Agent software uses openSSL, you must first download the separate Extreme Networks SSH2 software module that contains Secure Sockets Layer (SSL).



NOTE

You must download the Secure Shell (SSH2) module before downloading the CNA module.

If you attempt to download the CNA software module and you have not already downloaded the SSH2 software module, the system returns an error.

Running the Tests

The CNA Server requests the CNA Agent to run a specific test, and the CNA Agent runs the test and reports the results back to the CNA Server.

The CNA Agent can run the following tests:

- Traceroute—Measures per-hop round-trip delays to a target IP address by sending a sequence of hop-limited UDP messages, each with a time-to-live (TTL) value that is one greater than that of the preceding message
- RTP—Emulates VoIP traffic to measure delay, packet loss and jitter to another CNA Agent by sending a simulated RTP stream that is echoed back
- Ping—Sends an ICMP echo message to a target IP address and reports whether or not a response was returned
- TCPconnect—Attempts to establish a TCP connection to a specified port at a target IP address and reports whether the attempt succeeded or failed
- Merge—Used by CNA software to identify a single device with multiple IP addresses and to merge its multiple appearances into one in the network topology map

The CNA Agent starts the specified test within 100 ms after it receives an authenticated and correctly formatted test request from the CNA Server. The CNA Agent sends the test results to the CNA Server within 100 ms of test completion.

Configuring the CNA Agent

To run the tests, configure the following:

- Enable the CNA Agent.
- Configure the IP address the CNA Agent uses to communicate with the CNA Server.
- Configure the VLAN interface for the CNA Server
 - This step is optional. By default, the CNA Server uses the primary IP address on the switch's Default VLAN.
- Clear the counters.
 - This step is optional.
- Display the test results.

To save all these configurations, use the `save configuration` command.

Enabling the CNA Agent

To enable the CNA Agent (test plug), use the following command:

```
enable cna-testplug
```

After you enable the CNA Agent, you register the CNA Agent with the CNA Server, and the CNA Agent performs the requested network tests and reports the results.

To disable the CNA Agent, use the following command:

```
disable cna-testplug
```

Connecting to the CNA Server

After you enable the CNA Agent, you must configure this parameter to allow the CNA Agent to register with the CNA Server. Use the following command:

```
configure cna-testplug scheduler ipaddress <ip_address>
```

You enter the IP address of the CNA Server. (With ExtremeXOS software version 11.2, this must be an IPv4 address.)

After you configure the IP address for the CNA server, the CNA Agent and the CNA Server exchange SSL keys and establish encryption. After successful registration, you can connect with more than one CNA Server, in which case you share the encryption key you negotiated with your initial CNA Server connection.

At this time, the system establishes the socket connection to the CNA Server using this IP address. The CNA Agent listens for instructions for the testing from this IP address.

Configuring the Interface

By default, the Extreme Networks device uses the default VLAN as the interface that the CNA Agent (test plug) uses to receive test requests, conduct the tests, and send the results to the CNA Server. (The default VLAN belongs to the default virtual router: *VR-Default*).

If you want to change this interface, use the following command:

```
configure cna-testplug vlan <vlan_name>
```

If the VLAN has more than one IP address, the system uses the primary IP address.



NOTE

Extreme Networks recommends that you put IP telephones on the same virtual router.

Clearing the Counters

To clear the CNA Agent (test plug) counters, use the following command:

```
clear cna-testplug counters
```

This command clears the CNA Agent counters on the Extreme Networks devices and resets those counters to 0.

You can also use the `clear counters` command, which clears all the counters on the device including those associated with the CNA Agent.

Displaying CNA Agent Information

To display summaries of completed tests as well as the CNA Server (scheduler) connections and status for the CNA Agent (test plug), use the following command:

```
enable cna-testplug
```

Troubleshooting

If the CNA Agent is not able to register with the CNA Server, check the following items:

- Ensure the time on the Extreme Networks device is set correctly.
 - To display the time, use the `show switch` command.
 - To reset the time, use the `configure time <month> <day> <year> <hour> <min> <sec>` command.
- Ensure that the openSSL certificate on the CNA Server has not expired.

D

APPENDIX

Troubleshooting

This appendix includes the following sections:

- [Troubleshooting Checklists on page 1518](#)
- [LEDs on page 1521](#)
- [Using the Command Line Interface on page 1523](#)
- [Using ELRP to Perform Loop Tests on page 1530](#)
- [Using the Rescue Software Image on page 1534](#)
- [Debug Mode on page 1539](#)
- [Saving Debug Information on page 1540](#)
- [Evaluation Precedence for ACLs on page 1542](#)
- [TOP Command on page 1542](#)
- [TFTP Server Requirements on page 1543](#)
- [System Odometer on page 1543](#)
- [Temperature Operating Range on page 1545](#)
- [Unsupported Module Type on page 1545](#)
- [Corrupted BootROM on BlackDiamond 8800 Series Switches on page 1546](#)
- [Inserting Powered Devices in the PoE Module on page 1546](#)
- [Modifying the Hardware Table Hash Algorithm on page 1546](#)
- [Untagged Frames on the 10 Gbps Module on page 1549](#)
- [Understanding the Error Reading Diagnostics Message on page 1550](#)
- [Running MSM/MM Diagnostics from the Bootloader on page 1550](#)
- [Contacting Extreme Networks Technical Support on page 1551](#)

If you encounter problems when using the switch, this appendix may be helpful. If you have a problem not listed here or in the release notes, contact Extreme Networks Technical Support.

Troubleshooting Checklists

This section provides simple troubleshooting checklists for Layer 1, Layer 2, and Layer 3. The commands and recommendations described are applicable to both IPv4 and IPv6 environments unless otherwise specified. If more detailed information about a topic is available, you are referred to the applicable section in this appendix.

Layer 1

When troubleshooting Layer 1 issues, verify:

- The installation of cables and connectors.
- The behavior of LED status lights. For additional information about LEDs, see [“LEDs” on page 1521](#).
- That the port is enabled, the link status is active, and speed and duplex parameters match the port settings at the other end of the cable.

To display the configuration of one or more ports, use the `show ports configuration` command.

- That the packets are being received and transmitted.

To display the number of packets being received and transmitted, use the `show ports {<port_list> | stack-ports <stacking-port-list>} statistics {no-refresh}` command.

- That there are no packet errors.

To display packet error statistics, use the following commands:

- `show ports {<port_list> | stack-ports <stacking-port-list>} rxerrors {no-refresh}`—Displays receive error statistics
- `show ports {<port_list> | stack-ports <stacking-port-list>} txerrors {no-refresh}`—Displays transmit error statistics
- `show ports {mgmt | <port_list> |tag <tag>} collisions {no-refresh}`—Displays collision statistics

Layer 2

When troubleshooting Layer 2 issues, verify:

- That the MAC addresses are learned, in the correct Virtual LAN (VLAN), and are not blackhole entries.

To display FDB entries, use the `show fdb` command.

- Your VLAN configuration, including the VLAN tag, ports in the VLAN, and whether or not the ports are tagged.

To display detailed information for each VLAN configured on the switch, use the `show vlan detail` command.

For additional VLAN troubleshooting tips, see [“VLANs” on page 1527](#).

- Your Spanning Tree Protocol (STP) configuration, including the STP domain (STPD) number, VLAN assignment, and port state.

To display STP information, use the following commands:

- `show stpd detail`—Displays the STP settings on the switch
- `show stpd ports`—Displays the STP state of a port
- `show vlan stpd`—Displays the STP configuration of the ports assigned to a specific VLAN

For additional STP troubleshooting tips, see “STP” on page 1528.

Layer 3

When troubleshooting Layer 3 issues, verify:

- The IP address assigned to each VLAN router interface.

To display summary information for all of the VLANs configured on the device, use the `show vlan` command.

- That IP forwarding is enabled, the routing protocol is globally enabled, and the routing protocol is enabled for a VLAN.

To display the configuration information for a specific VLAN, use one of the following commands:

- `show ipconfig {ipv4} {vlan <vlan_name>}`—IPv4 environment
- `show ipconfig ipv6 {vlan <vlan_name> | tunnel <tunnelname>}`—IPv6 environment

- Which destination networks are in the routing table and the source of the routing entry.

To display the contents of the routing table or the route origin priority, use one of the following commands:

- `show iproute`—IPv4 environment
- `show iproute ipv6`—IPv6 environment

To display the contents of the routing table only for routes of a specified origin, use one of the following commands:

- `show iproute origin`—IPv4 environment
- `show iproute ipv6 origin`—IPv6 environment

- That the IP Address Resolution Protocol (ARP) table has the correct entries.



NOTE

The ARP table is applicable only in IPv4 environments.

To display the contents of the IP ARP table, use the `show iparp` command.

- That the Neighbor Discovery (ND) cache has the correct entries.



NOTE

The ND cache is applicable only in IPv6 environments.

To display the contents of the ND cache, use the `show neighbor-discovery cache ipv6` command.

- IP routing protocol statistics for the CPU of the switch.
Only statistics of the packets handled by the CPU are displayed. To display IP statistics for the CPU of the switch, use one of the following commands:
 - `show ipstats`—IPv4 environment
 - `show ipstats ipv6`—IPv6 environment
- Your Open Shortest Path First (OSPF) configuration, including the OSPF area ID, router state, link cost, OSPF timers, interface IP address, and neighbor list.

**NOTE**

OSPF is applicable only in IPv4 environments.

To display OSPF information, use the following commands:

- `show ospf`—Displays global OSPF information for the switch
 - `show ospf area`—Displays information related to OSPF areas
 - `show ospf area`—Displays detailed information related to OSPF areas
 - `show ospf interfaces detail`—Displays detailed information about OSPF interfaces
- Your OSPFv3 configuration, including the OSPFv3 area ID, router state, link cost, OSPFv3 timers, interface IP address, and neighbor list.

**NOTE**

OSPFv3 is applicable only in IPv6 environments.

To display OSPFv3 information, use the following commands:

- `show ospfv3`—Displays global OSPFv3 information for the switch
 - `show ospfv3 area`—Displays information related to OSPFv3 areas
 - `show ospfv3 interfaces`—Displays detailed information about OSPFv3 interfaces
- Your Routing Information Protocol (RIP) configuration, including RIP poison reverse, split horizon, triggered updates, transmit version, and receive version.

**NOTE**

RIP is applicable only in IPv4 environments.

To display detailed information about how you have RIP configured on the switch, use the `show rip` command.

- RIP activity and statistics for all VLANs on the switch.

**NOTE**

RIP is applicable only in IPv4 environments.

To display RIP-specific statistics for all VLANs, use the `show rip interface detail` command.

- Your RIP next generation (RIPng) configuration, including RIPng poison reverse, split horizon, triggered updates, transmit version, and receive version.

**NOTE**

RIPng is applicable only in IPv6 environments.

To display detailed information about how you have RIPng configured on the switch, use the `show ripng` command.

- RIPng activity and statistics for all VLANs on the switch.

**NOTE**

RIPng is applicable only in IPv6 environments.

To display RIPng-specific statistics for all VLANs, use the `show ripng interface` command.

- End-to-end connectivity.
To test for connectivity to a specific host, use the `ping` command.
- The routed path between the switch and a destination end station.
To verify and trace the routed path, use the `traceroute` command.

LEDs

Power LED does not light:

Check that the power cable is firmly connected to the device and to the supply outlet.

On powering-up, the MGMT LED lights yellow:

The device has failed its Power On Self Test (POST) and you should contact your supplier for advice.

A link is connected, but the Status LED does not light:

Check that:

- All connections are secure.
- Cables are free from damage.
- The devices at both ends of the link are powered-up.
- Both ends of the Gigabit link are set to the same autonegotiation state.

The Gigabit link must be enabled or disabled on both sides. If the two sides are different, typically the side with autonegotiation disabled will have the link LED lit, and the side with autonegotiation enabled will not be lit. The default configuration for a Gigabit port is autonegotiation enabled. Verify by entering the following command:

```
show ports configuration
```

On power-on, some I/O modules do not boot:

Check the output of the `show power budget` command to see if all power supplies display the expected input voltage. Also refer to the section “Power Management Guidelines” on page 95 for more detailed information about power management.

ERR LED on the Management Switch Fabric Module (MSM) turns amber:

Check the syslog message for “critical” software errors. To reset the ERR LED and clear the log, use the following command and reboot the switch:

```
clear log static
```

If you continue to see “critical” software errors or the ERR LED is still amber after issuing the `clear log static` command and a switch reboot, contact Extreme Networks Technical support for further assistance.

Status LED on the I/O module turns amber:

Check the syslog message for a related I/O module error. If the error is an inserted I/O module that conflicts with the software configuration, use one of the following commands to reset the slot configuration:

```
clear slot  
configure slot <slot> module <module_type>
```

Otherwise, contact Extreme Networks Technical Support for further assistance.

ENV LED on the MSM turns amber:

Check each of the power supplies and all of the fans. Additionally, you display the status in the `show power` and `show fans` displays.

Predictive Failure LED on the AC power supply blinks amber:

Check the current status of the power supply. If the speed of both fans is above 2000 RPM, the AC power supply unit (PSU) is operating normally and no failure is imminent. To check and view the health of the installed PSU, use the following command:

```
show power {<ps_num>} {detail}
```

Switch does not power up:

All products manufactured by Extreme Networks use digital power supplies with surge protection. In the event of a power surge, the protection circuits shut down the power supply.

To reset the power, unplug the switch for 1 minute, plug it back in, and attempt to power-up the switch. If this does not work, try using a different power source (different power strip/outlet) and power cord.

Using the Command Line Interface

This section describes helpful information for using and understanding the command line interface (CLI). This section describes the following topics:

- [General Tips and Recommendations on page 1523](#)
- [The Summit switch displays only the "\(pending-AAA\) login: " prompt \(SummitStack only\): on page 1525](#)
- [MSM Prompt—Modular Switches Only on page 1525](#)
- [Command Prompt on page 1526](#)
- [Port Configuration on page 1526](#)
- [Software License Error Messages on page 1527](#)
- [VLANs on page 1527](#)
- [STP on page 1528](#)
- [ESRP on page 1529](#)
- [VRRP on page 1530](#)

General Tips and Recommendations

The initial welcome prompt does not display:

Check that:

- Your terminal or terminal emulator is correctly configured
- Your terminal or terminal emulator has the correct settings:
 - 9600 baud
 - 8 data bits
 - 1 stop bit
 - no parity
 - XON/OFF flow control enabled

For console port access, you may need to press [Return] several times before the welcome prompt appears.

The SNMP Network Manager cannot access the device:

Check that:

- The Simple Network Management Protocol (SNMP) access is enabled for the system.
- The device IP address, subnet mask, and default router are correctly configured, and that the device has been reset.
- The device IP address is correctly recorded by the SNMP Network Manager (refer to the user documentation for the Network Manager).
- The community strings configured for the system and Network Manager are the same.
- The SNMPv3 USM, Auth, and VACM configured for the system and Network Manager are the same.

The Telnet workstation cannot access the device:

Check that:

- The device IP address, subnet mask, and default router are correctly configured, and that the device has been reset.
- You entered the IP address of the switch correctly when invoking the Telnet facility.
- Telnet access is enabled for the switch.

If you attempt to log in and the maximum number of Telnet sessions are being used, you should receive an error message indicating so.

Traps are not received by the SNMP Network Manager:

Check that the SNMP Network Manager's IP address and community string are correctly configured, and that the IP address of the Trap Receiver is configured properly on the system.

The SNMP Network Manager or Telnet workstation can no longer access the device:

Check that:

- Telnet access or SNMP access is enabled for the system.
- The port through which you are trying to access the device has not been disabled. If it is enabled, check the connections and network cabling at the port.
- The port through which you are trying to access the device is in a correctly configured Virtual LAN (VLAN).
- The community strings configured for the device and the Network Manager are the same.

Try accessing the device through a different port. If you can now access the device, a problem with the original port is indicated. Re-examine the connections and cabling.

A network problem may be preventing you from accessing the device over the network. Try accessing the device through the console port.

Permanent entries remain in the FDB:

If you have made a permanent entry in the FDB that requires you to specify the VLAN to which the entry belongs and then deleted the VLAN, the FDB entry remains. Although this does not harm the system, if you want to removed the entry, you must manually delete it from the FDB.

Default and static routes:

If you have defined static or default routes, those routes remain in the configuration independent of whether the VLAN and VLAN IP address that used them remains. You should manually delete the routes if no VLAN IP address is capable of using them.

You forget your password and cannot log in:

If you are not an administrator, another user having administrator access level can log in, delete your user name, and create a new user name for you, with a new password.

Alternatively, another user having administrator access level can log in and initialize the device. This will return all configuration information (including passwords) to the initial values.

In the case where no one knows a password for an administrator level user, contact your supplier.

The Summit switch displays only the "(pending-AAA) login: " prompt (SummitStack only):

It is possible that the switch has not yet been fully initialized in the SummitStack. Wait for the *Authentication Service (AAA) on the master node is now available for login.* message to appear and then log in normally.

It is also possible that the stack has no master-capable node. In this case, AAA authentication will not be possible. This can occur when a stack has been deliberately dismantled and stacking was not unconfigured beforehand.

In either case, you may log in to the node using the failsafe account. If you have forgotten this account, and the stack has no master-capable node or has been dismantled, see [“Rescuing a Stack That Has No Master-Capable Node” on page 214](#).

The “(Pending-AAA) login:“ prompt on other switches.

This login prompt is discussed in Chapter 1, Getting Started. See [“Logging In to the Switch”](#).

MSM Prompt—Modular Switches Only

You do not know which MSM you are connected to:

If you use a console connection to access and configure the switch, you should connect to the console port of the primary MSM, not the backup MSM. To determine which console port you are connected to use the `show switch` command. The output displays both the primary and backup MSMs, if installed, and an asterisk (*) appears to the right of the MSM you are connected to.

The following truncated sample output indicates that you are connected to MSM-A, the primary MSM:

```
MSM: MSM-A * MSM-B
```

You have user privileges, not administrator privileges, on the backup MSM:

If you establish a console connection to access the backup MSM, only user privileges are available. This is true regardless of the privileges configured on the primary MSM. If you enter an administrator level command on the backup MSM, the switch displays a message stating that the command is only supported on the primary MSM.

Node Prompt—SummitStack Only

You do not know which Node you are connected to:

If you use a console connection to access and configure the switch, you should connect to the console port of the master node. The word “Slot” followed by a hyphen and a single decimal digit slot number will be inserted into the prompt in stacking mode. A sample of this prompt is:

```
* Slot-6 Stack.21 #
```

The sample indicates a changed configuration (*), the stackable is in stacking mode and is currently using the slot number 6 in the active topology (“Slot-6 “), the system name is the default of “Stack”, the command about to be executed is the 21st command, and the user is logged in as the administrator on the Master node (#).

There will be no specific prompt that indicates the node role. Run `show switch` command to discover the identities of the Master and Backup nodes. A successful login on a Standby node will show the “>” character instead of the “#” character at the end of the prompt.

Command Prompt

You do not know if the switch configuration has been saved:

If an asterisk (*) precedes the command prompt, a new change to the switch configuration has not been saved. To save the configuration, use the `save configuration` command. After you save the configuration, the asterisk (*) no longer precedes the command prompt.

You do not know if you are logged in as an administrator or a user:

Observe the console prompt. If you are logged in as an administrator, the prompt ends with the hash symbol(#). If you are logged in as a user, the prompt ends with a greater than sign (>).

The following is sample output from an administrator-level account:

```
BD-10808.1 #
```

The following is sample output from a user-level account:

```
BD-10808.1 >
```

Port Configuration

No link light on 10/100 Base port:

If patching from a switch to another switch, ensure that you are using a category 5 (CAT5) crossover cable. This is a CAT5 cable that has pins 1 and 2 on one end connected to pins 3 and 6 on the other end.

Excessive RX CRC errors:

When a device that has autonegotiation disabled is connected to an Extreme Networks switch with autonegotiation enabled, the Extreme Networks switch links at the correct speed, but in half-duplex mode. The Extreme Networks switch 10/100 physical interface uses a method called *parallel detection* to bring up the link. Because the other network device is not participating in autonegotiation (and does not advertise its capabilities), parallel detection on the Extreme Networks switch is able only to sense 10 Mbps versus 100 Mbps speed and not the duplex mode. Therefore, the switch establishes the link in half-duplex mode using the correct speed.

The only way to establish a full-duplex link is either to force it at both sides, or run autonegotiation on both sides (using full-duplex as an advertised capability, which is the default setting on the Extreme Networks switch).



NOTE

A mismatch of duplex mode between the Extreme switch and another network device causes poor network performance. Viewing statistics using the `show ports rxerrors` command on the Extreme Networks switch may display a constant increment of CRC errors. This is characteristic of a duplex mismatch between devices. This is NOT a problem with the Extreme Networks switch.

Always verify that the Extreme Networks switch and the network device match in configuration for speed and duplex.

No link light on Gigabit fiber port:

Check that:

- The transmit fiber goes to the receive fiber side of the other device and vice-versa. All Gigabit fiber cables are of the crossover type.
- The Gigabit ports are set to Auto Off (using the command `configure ports <port_list> {medium [copper | fiber]} auto off speed <speed> duplex [half | full]`) if you are connecting the Extreme Networks switch to devices that do not support autonegotiation.

By default, the Extreme Networks switch has autonegotiation set to On for Gigabit ports and set to Off for 10 Gigabit ports.

- You are using multimode fiber (MMF) when using a 1000BASE-SX small form-factor pluggable (SFP), and single-mode fiber (SMF) when using a 1000BASE-LX SFP. 1000BASE-SX technology does not work with SMF. The 1000BASE-LX technology works with MMF but requires the use of a mode conditioning patchcord (MCP).

Software License Error Messages

You do not have the required software license:

If you attempt to execute a command and you do not have the required license, the switch returns the following message:

```
Error: This command cannot be executed at the current license level.
```

You have reached the limits defined by the current software license level:

If you attempt to execute a command and you have reached the limits defined by the current license level the switch returns the following message:

```
Error: You have reached the maximum limit for this feature at this license level.
```

See [Appendix A, “Feature License Requirements”](#) for information about licensing requirements.

VLANs

You cannot add a port to a VLAN:

If you attempt to add a port to a VLAN and get an error message similar to:

```
localhost:7 # configure vlan marketing add ports 1:1,1:2
Error: Protocol conflict when adding untagged port 1:1. Either add this port as tagged
or assign another protocol to this VLAN.
```

You already have a VLAN using *untagged* traffic on a port. Only one VLAN using *untagged* traffic can be configured on a single physical port.

You verify the VLAN configuration using the following command:

```
show vlan {virtual-router <vr-name>}
```

The solution for this error using this example is to remove ports 1 and 2 from the VLAN currently using untagged traffic on those ports. If this were the “default” VLAN, the command would be:

```
localhost:23 # configure vlan default delete ports 1:1,1:2
```

You can now re-enter the previous command without error:

```
localhost:26 # configure vlan marketing add ports 1:1,1:2
```

VLAN names:

There are restrictions on VLAN names. They cannot contain whitespaces and cannot start with a numeric value.

VLANs, IP addresses, and default routes:

The system can have an IP address for each configured VLAN. You must configure an IP address associated with a VLAN if you intend to manage (Telnet, SNMP, ping) through that VLAN or route IP traffic.

You can also configure multiple default routes for the system. The system first tries the default route with the lowest cost metric.

STP

You have connected an endstation directly to the switch and the endstation fails to boot correctly:

The switch has the Spanning Tree Protocol (STP) enabled, and the endstation is booting before the STP initialization process is complete. Specify that STP has been disabled for that VLAN, or turn off STP for the switch ports of the endstation and devices to which it is attempting to connect; then, reboot the endstation.

Spanning Tree Domain names:

There are restrictions on Spanning Tree Domain (STPD) names. They cannot contain whitespaces and cannot start with a numeric value.

You cannot add ports within a VLAN to the specified STPD:

Check to ensure that you are adding ports that already exist in the carrier VLAN.

If you see an error similar to the following:

```
Error: Cannot add VLAN default port 3:5 to STP domain
```

You might be attempting to add:

- Another 802.1D mode STP port to a physical port that already contains an 802.1D mode STP port (only one 802.1D encapsulation STP port can be configured on a particular STP port).
- A carrier VLAN port to a different STP domain than the carrier VLAN belongs.
- A VLAN and/or port for which the carrier VLAN does not yet belong.



NOTE

This restriction is only enforced in an active STPD and when you enable STP to make sure you have a legal STP configuration.

Only one carrier VLAN can exist in an STPD:

Only one carrier VLAN can exist in a given STPD although some of the ports on the carrier VLAN can be outside the control of any STPD at the same time.

The StpdID must be identical to the VLANid of the carrier VLAN in that STPD.

The switch keeps aging out endstation entries in the switch FDB:

If the switch continues to age out endstation entries in the switch FDB:

- Reduce the number of topology changes by disabling STP on those systems that do not use redundant paths.
- Specify that the endstation entries are static or permanent.

ESRP

ESRP names:

There are restrictions on Extreme Standby Router Protocol (ESRP) names. They cannot contain whitespaces and cannot start with a numeric value.

You cannot enable an ESRP domain:

Before you enable a specific ESRP domain, it must have a domain ID. A domain ID is either a user-configured number or the 802.1Q tag (VLANid) of the tagged master VLAN. The domain ID must be *identical* on all switches participating in ESRP for that particular domain. If you do not have a domain ID, you cannot enable ESRP on that domain.

Note the following on the interaction of tagging, ESRP, and ESRP domain IDs:

- If you have an untagged Master VLAN, you must specify an ESRP domain ID.
- If you have a tagged master VLAN, ESRP uses the 802.1Q tag (VLANid) of the master VLAN for the ESRP domain ID. If you do not use the VLANid as the domain ID, you must specify a different domain ID.

You cannot delete the master VLAN from the ESRP domain:

If you attempt to remove the master VLAN before disabling the ESRP domain, you see an error message similar to the following:

```
ERROR: Failed to delete master vlan for domain "esrp1" ; ESRP is enabled!
```

If this happens:

- Disable the ESRP domain using the `disable esrp` command.
- Remove the master VLAN from the ESRP domain using the `configure esrp delete master` command.

VRRP

You cannot define VRRP virtual router parameters:

Before configuring any virtual router parameters for VRRP, you must first create the VRRP instance on the switch. If you define VRRP parameters before creating the VRRP, you may see an error similar to the following:

```
Error: VRRP VR for vlan vrrp1, vrid 1 does not exist.  
Please create the VRRP VR before assigning parameters.  
Configuration failed on backup MSM, command execution aborted!
```

If this happens:

- Create a VRRP instance using the `create vrrp vlan vrid` command.
- Configure the VRRP instance's parameters.

Using ELRP to Perform Loop Tests

The Extreme Loop Recovery Protocol (ELRP) is used to detect network loops in a Layer 2 network. A switch running ELRP transmits multicast packets with a special MAC destination address out of some or all of the ports belonging to a VLAN. All of the other switches in the network treat this packet as a regular, multicast packet and flood it to all of the ports belonging to the VLAN. When the packets transmitted by a switch are received back by that switch, this indicates a loop in the Layer 2 network.

After a loop is detected through ELRP, different actions can be taken such as blocking certain ports to prevent loop or logging a message to system log. The action taken is largely dependent on the protocol using ELRP to detect loops in the network.

You can use ELRP on a “standalone” basis or with other protocols such as ESRP, as described in [“Using ELRP with ESRP” on page 1082](#). Protocols such as Ethernet Automatic Protection Switching (EAPS) require that a network have a ring topology to operate. In this case you can use ELRP to ensure that the network has a ring topology.

ExtremeXOS software does not support ELRP and Network Login on the same port.

The “standalone” ELRP commands determine whether or not a network has an Layer 2 loop. This section describes the following topics:

- [About Standalone ELRP on page 1530](#)
- [Configuring Standalone ELRP on page 1532](#)
- [Displaying Standalone ELRP Information on page 1533](#)

About Standalone ELRP

Standalone ELRP gives you the ability to send ELRP packets, either periodically or on an ad hoc “one-shot” basis on a specified subset of VLAN ports. If any of these transmitted packets is received back then standalone ELRP can perform a configured action such as sending a log message to the system log file, sending a trap to the SNMP manager, and disabling the port where the looped packet arrived.

Standalone ELRP allows you to:

- Configure ELRP packet transmission on specified VLANs.
- Specify some or all the ports of the VLAN for packet transmission. Each VLAN must be configured individually for ELRP.

**NOTE**

Reception of packets is not limited to any specific ports of the VLAN and cannot be configured.

- Save and restore standalone ELRP configuration across reboots.
- Request non-periodic or periodic transmission of ELRP packets on specified ports of a VLAN.

Non-periodic ELRP Requests

You can specify the number of times ELRP packets must be transmitted and the interval between consecutive transmissions.

A message is printed to the console and logged into the system log file indicating detection of network loop when ELRP packets are received back or no packets are received within the specified duration.

Periodic ELRP Requests

You can configure the interval between consecutive transmissions.

If ELRP packets are received back, a message is printed to the system log file and/or a trap is sent to the SNMP manager indicating detection of a network loop.

You have the option to configure the switch to automatically disable the port where the looped packet arrived as well as the length of time (in seconds) that the port should remain disabled. When this hold time expires, the port is automatically enabled.

Should a loop occur on multiple ports, only the first port in the VLAN on which the PDU is received is disabled. The second port is ignored for 1 or 2 seconds and then if another PDU is received, that port is disabled until the loop is gone. This prevents shutting down all ports in the VLAN.

Exclude Port List

When you have configured the switch to automatically disable the port where the looped packet arrived, there may be certain ports that you do not want disabled. You can then create a list of ports that are excluded from this automatic disabling and that will remain enabled. This list can also contain EAPS ring ports. You can also specify that EAPS ring ports are excluded. When this option is selected, the actual EAPS ring ports do not have to be explicitly listed.

You can configure any port on the switch into the exclude port list. The list can also be edited to add or delete any port on the switch. Then when ELRP detects a loop and the disable feature is enabled, it checks to see if the port from which the PDU arrived is on the user defined exclude port list or is part of a trunk port that is defined on the list. When the port is on the list, ELRP logs the event and does not disable the port. When the port is not on the list, ELRP disables the port.

Limitations . The following are limitations to this feature:

- A specified port is added to the list regardless of its corresponding VLAN.
- Only ports on the local switch can be added.
- A loop detected on an excluded port may persist indefinitely until user action is taken.

Configuring Standalone ELRP

The ELRP client (standalone ELRP) must be enabled globally in order for it to work on any VLAN. To globally enable the ELRP client, use the following command:

```
enable elrp-client
```

The ELRP client can be disabled globally so that none of the ELRP VLAN configurations take effect. To globally disable the ELRP client, use the following command:

```
disable elrp-client
```

Configuring Non-periodic Requests

To start one-time, non-periodic ELRP packet transmission on specified ports of a VLAN using a particular count and interval, use one of the following commands:

- `configure elrp-client one-shot <vlan_name> ports [<ports> | all] interval <sec> retry <count> [log | print | print-and-log]`
(This command is backward compatible with Extreme Networks switches running the ExtremeWare software.)
- `run elrp <vlan_name> {ports <ports>} {interval <sec>} {retry <count>}`

These commands start one-time, non-periodic ELRP packet transmission on the specified ports of the VLAN using the specified count and interval. If any of these transmitted packets is returned, indicating loopback detection, the ELRP client performs the configured actions of logging a message in the system log file and/or printing a log message to the console. There is no need to trap to the SNMP manager for non-periodic requests.

Configuring Periodic Requests

To start periodic ELRP packet transmission on specified ports of a VLAN using a particular interval, use the following command:

```
configure elrp-client periodic <vlan_name> ports [<ports> | all] interval <sec> [log | log-and-trap | trap] {disable-port {{duration <seconds>} | permanent}}
```

This command starts periodic ELRP packet transmission on the specified ports of the VLAN using a specified interval. If any of these transmitted packets is returned, indicating loopback detection, the ELRP client performs the configured action of logging a message in the system log file and/or sending a trap to the SNMP manager.

When the option of disabling a port is configured, you choose the duration, in seconds, as a hold time or you disable the port permanently. When ELRP disables the port, the operation is not persistent. When the switch is rebooted, the port is enabled when the switch comes up.

**NOTE**

ELRP detects loops on a per VLAN basis. When the `disable port` option is selected, keep in mind that the entire port will be disabled. This may affect connectivity for other VLANs configured on that port that did not have any data loop problems. ELRP also does not distinguish between uplink ports and host ports. When the `disable port` option is selected and ELRP detects a loop, any and all ports where the loop was detected will be disabled, including uplink ports.

To disable a pending one-shot or periodic ELRP request for a specified VLAN, use the following command:

```
unconfigure elrp-client <vlan_name>
```

Configuring Exclude Port List

To configure an ELRP exclude port list, use the following command:

```
configure elrp-client disable-ports [exclude | include] [ <ports> | eaps-ring-ports]
```

To disable an ELRP exclude port list, use the following command:

```
unconfigure elrp-client disable-ports
```

Displaying Standalone ELRP Information

To display summary ELRP status information, use the following command:

```
show elrp
```

To display information about ELRP disabled ports, use the following command:

```
show elrp disabled-ports
```

Example: ELRP on Protocol-based VLANs

The following example demonstrates running ELRP on a protocol-based VLAN. For ELRP to detect loops on a protocol-based VLAN (other than the protocol `any`), you need to add the ethertype `0x00bb` to the protocol.

```
Example
# Create VLANs
create vlan v1
create vlan v2

# Protocol filter configuration
configure vlan v1 protocol IP
configure vlan v2 protocol decnet

# Add ports to the VLAN
configure vlan v1 add ports 1
configure vlan v2 add ports 2
```

```
# Enable ELRP on the create VLANs
enable elrp-client
configure elrp-client periodic v1 ports all interval 5 log
configure elrp-client periodic v2 ports all interval 5 log

# Add the ethertype to the protocol
configure protocol IP add snap 0x00bb
configure protocol decnet add snap 0x00bb
```

VLANs v1 and v2 can then detect the loop on their respective broadcast domains.

Using the Rescue Software Image



WARNING!

The rescue image completely re-initializes the system. All data residing on the switch is cleared, including configuration files, policy files, and other system-related files. Use this feature only with the guidance of Extreme Networks Technical Support.

The rescue software image recovers a switch that does not boot up by initializing the internal memory card and installing the ExtremeXOS software on both primary and secondary images of that card. To use the rescue software image, you must be running ExtremeXOS 11.1 or later. Earlier versions of ExtremeXOS do not support the rescue software image.

BlackDiamond X8 series switches and BlackDiamond 8800 series switches support loading the rescue image to the compact flash card installed in the MSM. For more information see [“Obtaining the Rescue Image from a Compact Flash Card” on page 1536](#).

Before you begin the recovery process, collect the following information:

- IP address, netmask, and gateway for the switch
- IP address of the Trivial File Transfer Protocol (TFTP) server that contains the ExtremeXOS image
- ExtremeXOS image filename (the image has a .xos filename extension)



NOTE

The rescue process initializes the primary and secondary images with the ExtremeXOS software image. No additional software packages or configuration files are preserved or installed. This process takes a minimum of 7 minutes to complete. To install additional modular software packages, BootROM images (BlackDiamond 10808 switch only), and configuration files, see [Appendix B, “Software Upgrade and Boot Options,”](#) for more information.

Obtaining the Rescue Image from a TFTP Server

To recover the switch, you must enter the Bootloader and issue a series of commands. To access the Bootloader:

- 1 Attach a serial cable to the console port of the MSM.
- 2 Attach the other end of the serial cable to a properly configured terminal or terminal emulator. The terminal settings are:
 - 9600 baud
 - 8 data bits
 - 1 stop bit
 - no parity
 - XON/OFF flow control enabled
- 3 Reboot the MSM and press the spacebar key on the keyboard of the terminal during the boot up process.



NOTE

You must press the spacebar key immediately after a power cycle of the MSM in order to get into the Bootloader application.

On BlackDiamond 8800 series switches, when you see the BootROM banner, press the spacebar key to get into the Bootloader application.

On the BlackDiamond X8 series switches, press and hold the spacebar key to enter the bootROM (actually a BIOS) as soon as you see `CF card tested OK` on the screen.

As soon as you see the `BOOTLOADER ->` prompt (BlackDiamond 10808 switch) or the `BootRom ->` prompt (BlackDiamond X8, 8800, 12800 series switches), release the spacebar. From here, you can begin the recovery process.

To obtain the rescue image and recover the switch:

- 1 Provide the network information (IP address, netmask, and gateway) for the switch using the following command:

```
configip ipaddress <ip-address>[/<netmask>] gateway <gateway-address>
```

Where the following is true:

- `ip-address`—Specifies the IP address of the switch
- `netmask`—Specifies the netmask of the switch
- `gateway-address`—Specifies the gateway of the switch

- 2 Download the ExtremeXOS image using the following command:

```
download image <tftp-address> <filename>
```

Where the following is true:

- `tftp-address`—Specifies the IP address of the TFTP server that contains the ExtremeXOS image
- `filename`—Specifies the filename of the ExtremeXOS image

If you attempt to download a non-rescue image, the switch displays an error message and returns you to the `BOOTLOADER ->` (BlackDiamond 10808 switch) or the `BootRom ->` (BlackDiamond 8800 and BlackDiamond 12800 series switches) command prompt.

After you download the ExtremeXOS image file, the switch installs the software and reboots. After the switch reboots, the switch enters an uninitialized state. At this point, configure the switch and save your configuration. In addition, if you previously had modular software packages installed, you must re-install the software packages to each switch partition. For more information about installing software packages, see [Appendix B, “Software Upgrade and Boot Options.”](#)

If you are unable to recover the switch with the rescue image, or the switch does not reboot, contact Extreme Networks Technical Support.

Obtaining the Rescue Image from a Compact Flash Card

In addition to recovering the switch using the internal memory card and the management port, there is also support for loading the rescue image to the compact flash card installed in the MSM. The compact flash card must be file allocation table (FAT) formatted. Use a PC with appropriate hardware such as a compact flash reader/writer and follow the manufacturer’s instructions to access the compact flash card and place the image onto the card.



NOTE

This feature is supported only on BlackDiamond 8800 series switches.

Before you remove or install any hardware, review the hardware documentation which is listed in the Preface.

To recover the switch, you must remove power from the switch, install an appropriate compact flash card into the MSM, and enter the Bootloader to issue a series of commands.

To access the Bootloader:

- 1 Remove all power cords from the power supplies switch. There should be no power to the switch.
- 2 Insert the FAT formatted compact flash card into the compact flash slot of the MSM installed in slot 5/A.
- 3 Remove the MSM installed in slot 6/B. Place the MSM in a safe location and do not re-install it until you finish recovering the switch.
- 4 Attach a serial cable to the console port of the MSM installed in slot 5/A.
- 5 Attach the other end of the serial cable to a properly configured terminal or terminal emulator. The terminal settings are:
 - 9600 baud
 - 8 data bits
 - 1 stop bit
 - no parity
 - XON/OFF flow control enabled
- 6 Provide power to the switch by re-inserting the power cords into the power supplies.
- 7 Immediately press the spacebar until the `BootRom ->` prompt appears.



NOTE

You must press the spacebar key immediately after a power cycle of the MSM in order to get into the Bootloader application.

As soon as you see the `BootRom ->` prompt, release the spacebar. From here, you can begin the recovery process.

To obtain the rescue image that you placed on the compact flash card and recover the switch:

- 1 Download the ExtremeXOS image that is already on the compact flash card using the following command:

```
boot file <filename>
```

Where the `filename` specifies the image file for the BlackDiamond 8800 series switches.

- 2 At the `BootRom ->` prompt, press [Return]. The following message appears:

```
ok to continue
```

Type `YES` to begin the recovery process. This takes a minimum of 7 minutes.

- 3 After the process runs, the `BootRom ->` prompt displays the following message:

```
****press enter to reboot****
```

Press [Return] to reboot the switch. The switch reboots and displays the login prompt. You have successfully completed the setup from the compact flash card.

- 4 Remove the compact flash card installed in the MSM.

After you download the ExtremeXOS image file, the switch installs the software and reboots. After the switch reboots, the switch enters an uninitialized state. At this point, configure the switch and save your configuration. In addition, if you previously had modular software packages installed, you must re-install the software packages to each switch partition. For more information about installing software packages, see [Appendix B, “Software Upgrade and Boot Options.”](#)

If you are unable to recover the switch with the rescue image, or the switch does not reboot, contact Extreme Networks Technical Support.

Performing Compact Flash Recovery Using a USB Memory Drive

In addition to recovering the switch using the network, there is also support on the BlackDiamond X8 for rescuing from a USB memory drive. The USB memory drive must be file allocation table (FAT) formatted. Use a computer with appropriate hardware to place the rescue image onto the memory drive. Place the rescue image in the top level directory of the memory drive.



NOTE

This feature is supported only on BlackDiamond X8 series switches. Before you remove or install any hardware, review the hardware documentation which is listed in the preface.

Setup and Access to the BootROM.

- 1 Remove all power cords from the power supply switch. There should be no power to the switch.
- 2 Insert the FAT formatted USB memory drive into the bottom USB port (labeled USB-1) of the MM installed in the slot you wish to recover.
- 3 If present, remove the MM from the other management slot. Place the MM in a safe location and do not reinstall it until you finish recovering the switch.
- 4 Attach a rollover serial cable to the console port of the MM still installed.
- 5 Attach the other end of the serial cable to a properly configured terminal or terminal emulator. The terminal settings are:

- 9600 baud
 - 8 data bits
 - 1 stop bit
 - no parity
 - XON/OFF flow control enabled
- 6 Provide power to the switch by re-inserting the power cords into the power supplies.
 - 7 Immediately press the spacebar until the BootROM -> prompt appears.

Determine the Current BootROM Image Version.

- 1 Use the “vers” command at the BootROM prompt.

```

BootRom > vers
EFI Specification Revision : 2.0
EFI Vendor                 : INSYDE Corp.
EFI Revision               : 4096.1
EFI Build Version          : Release8_6_1
Extreme Version            : 1.0.0.6
Build Date                 : 12/03/01
Build Time                 : 17:03:03

```

- 2 If the Extreme Version is 1.0.0.5 or earlier, you must recover the compact flash using TFTP.
- 3 If the Extreme Version is exactly 1.0.0.6, then you must first locate the drive letter that contains your rescue image using these BIOS commands:
- 4 If the Extreme Version is 1.0.0.1 or greater, proceed with the instructions in the following section directly from the BootROM -> prompt.

Install the ExtremeXOS Image.

- 1 Install the image from the memory drive using the following command:

```
download image usb <filename>
```

Where the <filename> specifies the desired image file for the BlackDiamond X series switches.

Example for BIOS version 1.0.0.6:

```
fs2:\> download image usb bdX-15.1.1.6.xos
```

Example for BIOS version 1.0.0.7 or greater:

```
BootRom > download image usb bdX-15.1.1.6.xos
```

- 2 When prompted to continue, type YES to begin the recovery process. This takes a minimum of 7 minutes.
After the process runs, the BootRom prompts you to reboot.
- 3 Follow the on-screen instructions to reboot. The switch reboots, and then displays the login prompt. The recovery process from the memory drive is complete.
- 4 Remove the USB Memory Stick installed in the MM.
- 5 If applicable, re-insert the secondary MM and synchronize it via the "synchronize" command from the Master MM's console.

Rescuing a Node in a SummitStack

You can use the rescue option on a node if it becomes unbootable due to a corrupt image. The rescue operation is independent of the SummitStack feature.

To rescue a node:

- 1 Establish a terminal session using the console port of the node.
- 2 Reboot this node. While rebooting enter the BootROM program. To enter the bootrom, wait until you see the message "Starting Default Bootloader..." and then press and hold the space bar until the BootROM prompt appears.

- 3 Provide the network information (IP address, netmask, and gateway) for the switch using the following command:

```
config ipaddress <ip-address>[/<netmask>] gateway <gateway-address>
```

Where the:

- ip-address—Specifies the IP address of the switch
- netmask—Specifies the netmask of the switch
- gateway-address—Specifies the gateway of the switch

- 4 Download the ExtremeXOS image using the following command:

```
download image <tftp-address> <filename>
```

Where the:

- tftp-address—Specifies the IP address of the TFTP server that contains the ExtremeXOS image
- filename—Specifies the filename of the ExtremeXOS image

If you attempt to download a non-rescue image, the switch displays an error message and returns you to the BootROM command prompt.

After you download the ExtremeXOS image file, the switch installs the software and reboots. After the switch reboots, the switch enters an uninitialized state. At this point, configure the switch and save your configuration. In addition, if you previously had modular software packages installed, you must reinstall the software packages to each switch partition. For more information about installing software packages, see [Appendix B, "Software Upgrade and Boot Options."](#)

If you are unable to recover the switch with the rescue image, or the switch does not reboot, contact Extreme Networks Technical Support.

The rescue process:

- Does not affect stacking configuration parameters.
- Sets the security configuration to the factory defaults.

Debug Mode

The Event Management System (EMS) provides a standard way to filter and store messages generated by the switch. With EMS, you must enable debug mode to display debug information. You must have administrator privileges to use these commands. If you do not have administrator privileges, the switch rejects the commands.

To enable or disable debug mode for EMS, use the following commands:

```
enable log debug-mode  
disable log debug-mode
```

After debug mode has been enabled, you can configure EMS to capture specific debug information from the switch. Details of EMS can be found in [Chapter 11, "Status Monitoring and Statistics."](#)

Saving Debug Information

You can save switch data and statistics to a network TFTP server, an internal memory card that comes preinstalled in the switch, a removable compact flash card (BlackDiamond 8800, 10800, and 12800 series switches), or a removable USB 2.0 storage device (Summit X460, X480, X650, X670, and X670V switches). With assistance from Extreme Networks Technical Support personnel, you can configure the switch to capture troubleshooting information, such as a core dump file, to these locations.

The switch only generates core dump files in the following situations:

- If an ExtremeXOS process fails.
- When forced under the guidance of Extreme Networks Technical Support.

The core dump file contains a snapshot of the process when the error occurred.



NOTE

Use the commands described in this section only under the guidance of Extreme Networks Technical Support personnel to troubleshoot the switch.

This section describes the following topics:

- [Enabling the Switch to Send Debug Information to the Internal Memory Card or Removable Storage Device on page 1540](#)
- [Copying Debug Information to Removable Storage Devices on page 1541](#)
- [Copying Debug Information to a TFTP Server on page 1541](#)
- [Managing Debug Files on page 1542](#)



NOTE

Before you can enable and save process core dump information to removable storage devices, you must install a compact flash card or USB 2.0 storage device. For more information about installing removable storage devices, refer to the hardware documentation which is listed in the Preface.

Enabling the Switch to Send Debug Information to the Internal Memory Card or Removable Storage Device

To enable the switch to save process core dump information to the internal memory card or a removable storage device, use the following command:

```
configure debug core-dumps [internal-memory | memorycard | off]
```

A removable storage device is a compact flash card on a BlackDiamond 8800, 10800, or 12800 series switch, or a USB 2.0 storage device on a BlackDiamond X8 or Summit X460, X480, X650, X670, or X670V switch.

Core dump files have a .gz file extension. The filename format is: `core.<process-name.pid>.gz` where `process-name` indicates the name of the process that failed and `pid` is the numerical identifier of that process. If you save core dump files to a switch with a compact flash card, the filename also includes the affected MSM: MSM-A or MSM-B.

If you configure the switch to write core dump files to the internal memory card and attempt to download a new software image, you might have insufficient space to complete the image download. If this occurs, you must decide whether to continue the software download or move or delete the core dump files from the internal memory. For example, if your switch supports a removable storage device with space available, transfer the files to the storage device. On switches that do not have a removable storage device, transfer the files from the internal memory card to a TFTP server. This frees up space on the internal memory card while keeping the core dump files.

Copying Debug Information to Removable Storage Devices

To save and copy debug information to the specified compact flash card or USB 2.0 storage device, use the following command:

```
save debug tracefiles memorycard
```

After the switch writes a core dump file or other debug information to the storage device, and before you can view the contents on the device, you must ensure it is safe to remove the device from the switch. Use the `eject memorycard` command to prepare the device for removal. After you issue the `eject memorycard` command, you can manually remove the storage device from the switch and read the data on the device.

To access and read the data on a removable storage device, use a PC with the appropriate hardware, such as a compact flash reader/writer and follow the manufacturer's instructions to access the compact flash card and read the data.

Copying Debug Information to a TFTP Server

To save and copy debug information to the specified TFTP server, use the following command:

```
upload debug [<hostname> | <ipaddress>] {{vr} <vrname>}
```

Progress messages are displayed that indicate the file being copied and when the copying is finished. Depending on your platform, the switch displays a message similar to the following:

```
The following files on have been uploaded:
Tarball Name: TechPubsLab_C_09271428.tgz
./primary.cfg
```

You can also use this command in conjunction with the `show tech` command. Prior to uploading debug information files, the switch prompts you with the following message to run the `show tech` command with the `logto` file option:

```
Do you want to run show tech logto file first? (y/n)
```

Enter `y` to run the `show tech` command before uploading debug information. If you enter `y`, the `show_tech.log.tgz` file is included during the upload. Enter `n` to upload debug information without running the `show tech` command.

After you upload the debug information, you should see a compressed TAR file on the TFTP server, which contains the debug information.

The TAR file naming convention is

```
<SysName>_<{slot#}|A|B|I|C>_<Current Time>.tgz
- Current Time = mmddhhmm ( month(01-12), date(01-31), hour(0-24), minute(00-59) ).
```

SummitStack only—To get debug information from a node in the SummitStack that is not a master node, you must configure an alternate IP address on the node and have its management port connected. You may then use the `tftp` command to upload specific files. The `upload debug` command functions only on the master node.

Managing Debug Files

For the purposes of this section, it is assumed that you have configured the switch to send core dump information under the guidance of Extreme Networks Technical Support.

Managing the debug files might include any of the following tasks: renaming or copying a core dump file, displaying a comprehensive list of files including core dump files, transferring core dump files, and deleting a core dump file. You can manage the debug files using the same commands that you use to manage other switch files. For information on managing switch files, see [Chapter 3, “Managing the ExtremeXOS Software.”](#)



NOTE

Filename are case-sensitive. For information on filename restrictions, refer to the specific command in the ExtremeXOS Command Reference Guide.

Evaluation Precedence for ACLs

The ACLs on a port are evaluated in the following order:

- Persistent dynamic ACLs
- Host-integrity permit ACLs
- MAC source address deny ACLs
- Source IP lockdown source IP permit ACLs
- Source IP lockdown deny all ACLs
- ARP validation CPU ACLs
- ACLs created using the CLI
- DoS Protect-installed ACLs
- Sentiariant-installed ACLs
- MAC-in-MAC installed ACLs
- ACLs applied with a policy file (see [Chapter 18, “ACLs,”](#) for precedence among these ACLs)

For information on policy files and ACLs, see [Chapter 17, “Policy Manager,”](#) and [Chapter 18, “ACLs.”](#)

TOP Command

The `top` command is a UNIX-based command that displays real-time CPU utilization information by process. The output contains a list of the most CPU-intensive tasks and can be sorted by CPU usage, memory usage, and run time. For more detailed information about the `top` command, refer to your UNIX documentation.

TFTP Server Requirements

Extreme Networks recommends using a TFTP server that supports blocksize negotiation (as described in RFC 2348, *TFTP Blocksize Option*), to enable faster file downloads and larger file downloads.

System Odometer

Each field replaceable component contains a system odometer counter in EEPROM. The `show odometers` command displays an approximate days of service duration for an individual component since the component was manufactured.

Monitored Components

On a modular switch, the odometer monitors the following components:

- Chassis
- MSMs
- I/O modules
- Power controllers

On Summit family switches, the odometer monitors the following components:

- Switch
- XGN-2xn card

Recorded Statistics

The following odometer statistics are collected by the switch:

- Service Days—The amount of days that the component has been running
- First Recorded Start Date—The date that the component was powered-up and began running

Depending on the software version running on your switch, the modules installed in your switch, and the type of switch you have, additional or different odometer information may be displayed.

The following is sample output from a BlackDiamond 10808 switch:

Field Replaceable Units	Service Days	First Recorded Start Date
Chassis : BD-10808	107	Feb-23-2004
Slot-1 : G60X	99	Dec-10-2003
Slot-2 : G60X	74	Mar-22-2004
Slot-3 : G60X	151	Jan-12-2004
Slot-4 :		
Slot-5 : 10G6X	49	Apr-09-2004
Slot-6 :		
Slot-7 : G60T	184	Dec-03-2003
Slot-8 : 10G6X	146	Jan-12-2004
MSM-A : MSM-1XL	62	Apr-21-2004
MSM-B : MSM-1XL	172	Dec-14-2003

```
PSUCTRL-1 : 152 Mar-17-2004
PSUCTRL-2 :
```

The following is sample output from a BlackDiamond 8800 series switch:

Field Replaceable Units	Service Days	First Recorded Start Date
-----	-----	-----
Chassis : BD-8810	209	Dec-07-2004
Slot-1 : G48T	208	Dec-07-2004
Slot-2 : 10G4X	219	Nov-02-2004
Slot-3 : G48T	228	Oct-26-2004
Slot-4 : G24X	226	Oct-19-2004
Slot-5 : G8X	139	Dec-07-2004
Slot-6 :		
Slot-7 : 10G4X	160	Dec-16-2004
Slot-8 : 10G4X	133	Dec-14-2004
Slot-9 : G48P	111	Nov-04-2004
Slot-10 :		
MSM-A : MSM-48C	137	Dec-07-2004
MSM-B :		
PSUCTRL-1 :	209	Dec-07-2004
PSUCTRL-2 :	208	Dec-07-2004

The following is sample output from a BlackDiamond 12804 switch:

Field Replaceable Units	Service Days	First Recorded Start Date
-----	-----	-----
Chassis : BD-8904	40	Sep-22-2005
Slot-1 : G20XT	20	Nov-10-2005
Slot-2 :		
Slot-3 :		
Slot-4 :		
Slot-5 :		
Slot-6 : G20T	20	Nov-10-2005
Slot-7 :		
Slot-8 :		
MSM-A : MSM-5	20	Nov-10-2005
MSM-B : MSM-5	20	Nov-10-2005
PSUCTRL-1 :	0	Nov-05-2005
PSUCTRL-2 :	0	Nov-05-2005

The following is sample output from a Summit series switch:

Field Replaceable Units	Service Days	First Recorded Start Date
-----	-----	-----
Switch : SummitX450-24t	7	Dec-08-2004
XGM-2xn-1 :		

Temperature Operating Range

Modular Switches

On modular switches, each I/O module and MSM/MM has its own temperature sensor, normal temperature range and minimum and maximum temperature threshold, and status. See the `show temperature` command for information about each module.

- If the temperature on any I/O module or MSM is out of its normal range, an error message is logged. The Status column in `show temperature` shows `Warning`.
- If the temperature on any I/O module or MSM was out of normal range, then returns back to its normal range, a Notice message is logged. The Status column in `show temperature` shows `Normal`.
- If the temperature on any I/O module is above its maximum allowed, or below its minimum allowed, that I/O module is powered down and marked `Failed` in `show slot`, and `Error` in `show temperature`.
- If the temperature on any MSM is above its maximum allowed, or below its minimum allowed, that MSM is marked `FAIL (OverHeat)` in `show switch`, `Failed` in `show slot`, and `Error` in `show temperature`. If that MSM was the primary, the other MSM becomes primary. MSMs out of allowed temperature range are not powered down (by hardware design), nor are they rebooted.
- Beyond the mechanisms above, you can use the UPM feature to take any further desired actions when an I/O module or MSM overheats.

Summit Family Switches and SummitStack

On Summit family switches, if a switch runs outside the expected range, the switch logs an error message, generates a trap, and continues running. No components are shutdown. To verify the state of the switch, use either the `show switch` or `show temperature` commands. If the temperature exceeds the maximum limit, the `show switch` output indicates the switch in an `OPERATIONAL (Overheat)` mode, and the `show temperature` output indicates an error state due to overheat.

On a SummitStack, use the `show temperature` command to see the temperature information of all active nodes in the stack.

Unsupported Module Type

BlackDiamond 10808 and BlackDiamond 8800 Series Switches Only

BlackDiamond 10808 Switch—If you are running ExtremeXOS 11.2 or earlier and install a module that is not supported by the currently running software image, the console displays a message similar to the following:

```
Msg on boot up "HEEELLLPPPP!!! Unknown cardtype" due to image does not support the blade.
```

If you see this message, the switch does not checkpoint the configuration or synchronize the primary and backup MSMs until you remove the unsupported module.

BlackDiamond 8800 Series Switches—If you install a module that is not supported by the currently running software image, the console displays a message similar to the following:

```
"Unable to read cardtype for slot 4"
```

If you see this message, the switch checkpoints the configuration and synchronizes the primary and backup MSMs; however, the unsupported module is not brought up and is not available for use. If you have an unsupported module installed and use the `show slot` command, the slot state appears as Empty.

Corrupted BootROM on BlackDiamond 8800 Series Switches

If your default BootROM image becomes corrupted, you can force the MSM to boot from an alternate BootROM image, by inserting a pen into the Alternate (A) and Reset (R) holes on the BlackDiamond 8000 series MSM and applying pressure. The alternate BootROM image also prints boot progress indicators, and you can later use this alternate image to re-install a new default BootROM image. Finally, a corrupted compact flash card can be recovered from either the Alternate or Default BootROM.

For more information, refer to the hardware documentation which is listed in the Preface.

Inserting Powered Devices in the PoE Module

BlackDiamond 8800 Series Switches Only

To reduce the chances of ports fluctuating between powered and non-powered states, newly inserted powered devices (PDs) are not powered when the actual delivered power for the module is within approximately 19 W of the configured inline power budget for that slot. However, actual aggregate power can be delivered up to the configured inline power budget for the slot (for example, when delivered power from ports increases or when the configured inline power budget for the slot is reduced).

Modifying the Hardware Table Hash Algorithm

BlackDiamond X8 Switches

A 40 Gb port must use multiple 20 Gb HGd links to carry its traffic. In the degenerate case, a particular link is always the target of the hash result. With a 40 Gb link hashing into a 20 Gb link, half the traffic is lost. ExtremeXOS attempts to configure the packet hash algorithm to accommodate most common situations; however, some customers may have uncommon situations and may wish to adjust the hash. For this reason, the user can specify values for some of the hash parameters in normal packet hash mode:

- Source port hash (cannot be used when 40 Gb ports are in use)
- Packet field hash calculation algorithm (CRC or XOR)

The packet hash is configurable. A Dynamic Load Balance (DLB) algorithm allows distribution of flows to the links in the switch fabric trunk that are currently carrying the least load. DLB uses the packet

field hash, but does not use the hash code that is reduced to a number modulo the number of links in the group. Instead the number used is 15 bits for a total of 32 K possible hash codes. This 15-bit hash code indexes into a 32 K-entry “flow table”. Each time an unused entry is allocated to one or more “micro-flows” (i.e., to flows that generate the same 15-bit hash value), a load calculation is performed and the link with the most available bandwidth is assigned to the flow table entry. DLB offers two modes:

- Spray mode causes the link assignment to occur on every packet transmission. This is similar to a “round-robin” hash. Every packet goes to the link with the least load, but ordering within flows is not guaranteed. This mode is useful for Bandwidth Management Testing (BMT).
- Eligibility mode keeps the link fixed to the flow entry until a 32 ms inactivity timeout occurs. Ordering within flows is guaranteed.

For blades that provide 10 Gb ports only (and for 40 Gb blades that are entirely configured for 10 Gb operation), source port hashing will be used by default. While source port hashing can be used for non-blocking operation, such operation depends on the switch fabric distribution. For example, suppose three 10 Gb ports on one BDXA-10G48X card hash to the same switch fabric “channel.” Also suppose that the three 10 Gb ports’ traffic is aggregated into the same 40 Gb port on a different I/O blade. Since each switch fabric channel can only provide 20 Gb of bandwidth to a single 40 Gb port, then the switch fabric channel will try to send 30 Gbps of Ethernet packets to the same 20 Gb switch fabric link, causing congestion in the channel on the FM blade.

To avoid this situation, the user can configure DLB Eligibility mode, which will cause per 10 Gb Ethernet port traffic to be distributed to all switch fabric channels instead of being sent to the same channel.

Use the following command:

```
configure forwarding fabric hash
[default |
source-port |
packet {algorithm [crc |xor] |
dynamic-mode [spray | eligibility | none]}]
{slot <slot-number>}
```

BlackDiamond 8800 Series Switches, SummitStack, and Summit Family Switches Only

With hardware forwarding, the switch stores addresses in the hardware table to quickly forward packets to their destination. The switch uses a hash algorithm to decide where to store the addresses in the hardware table. The standard, default hash algorithm works well for most systems; however, for some addresses with certain patterns, the hardware may attempt to store address information in the same section of the hardware. This can cause an overflow of the hardware table even though there is enough room to store addresses.

Error Messages Displayed With ExtremeXOS 11.4 and Earlier. If you experience a full hardware table that affects Layer 2, IP local host, and IP multicast forwarding, you see messages similar to the following in the log:

```
<Info:HAL.IPv4Adj.Info> : adj 136.159.188.109: IP add error is Table full for new or
newly resolved ARP, egress valid
<Info:HAL.IPv4Adj.Info> : adj 136.159.188.109: returned -17 for L3 table bucket 181
<Warn:HAL.IPv4Mc.Warning> : Could not allocate a hardware S,G,V entry
(889f4648,effffffa,70) - hardware table resource exceeded (rv=-17).
```

Error Messages Displayed With ExtremeXOS 11.5 and Later. If you experience a full hardware table that affects Layer 2, IP local host, and IP multicast forwarding, you see messages similar to the following in the log:

```
<HAL.IPv4Adj.L3TblFull> MSM-A: IPv4 unicast entry not added. Hardware L3 Table full.
<Card.IPv4Adj.Warning> Slot 4: IPv4 unicast entry not added. Hardware L3 Table full.
<HAL.IPv4Mc.GrpTblFullEnt> MSM-A: IPv4 multicast entry (10.0.0.1,224.1.1.1,vlan 1) not
added. Hardware Group Table full.
<Card.IPv4Mc.Warning> Slot-4: IPv4 multicast entry not added. Hardware L3 Table full.
```

Configuring the Hash Algorithm

If you experience a full hardware table, you can configure a different hash algorithm to distribute the L2 and L3 addresses differently in the hardware table. You must save your configuration and reboot the switch to modify the hash algorithm used by the hardware table.



NOTE

Modify the hardware table hash algorithm only with the guidance of Extreme Networks technical personnel.

To modify the hardware table utilization, use the following command:

```
configure forwarding hash-algorithm [crc16 | crc32] {dual-hash [on | off]}
```

- In ExtremeXOS 11.5, the default hash algorithm is crc32.
- In ExtremeXOS 11.4 and earlier, the default hash algorithm is crc16.
- The `dual-hash [on | off]` parameter applies only to BlackDiamond 8800 series switches. It allows you to disable dual-hashing on BlackDiamond 8000 c-, xl-, and xm-series modules. The default value for dual-hash is on.

After you enter the command, the switch displays a message similar to the following:

```
Warning: This command will take effect only after a save and reboot
```

Upgrading to ExtremeXOS 11.5. When you upgrade to ExtremeXOS 11.5, the hash algorithm automatically becomes crc32 because crc32 typically yields better hash distribution. For example, if you saved a configuration using an image from ExtremeXOS 11.4 or earlier with the hash algorithm set to crc16, when ExtremeXOS 11.5 loads on the switch, the hash algorithm becomes crc32. To change the hash algorithm to crc16, use the `configure forwarding hash-algorithm crc16` command and save your switch configuration.

On BlackDiamond 8800 series switches, you can also select the dual hashing recursion level. Use the following command:

```
configure forwarding hash-recursion-level <0-3>
```

This command does not require a system reboot but the new recursion level takes effect only for addresses that are added after the command is issued.

Viewing the Hash Algorithm Setting

To view the hardware table settings on the switch, including the configured hash algorithm and the current hash algorithm, use the following command:

```
show forwarding configuration
```

The following is sample output from this command

```
BD-8810.1 # show forwarding configuration
```

```
L2 and L3 Forwarding table hash algorithm:
```

```
  Configured hash algorithm:      crc16
```

```
  Current hash algorithm:        crc32
```

NOTE: A save and reboot are required before the configured hash will take effect.

```
L3 Dual-Hash configuration: (Applies to "c"-series HW only)
```

```
  Configured setting:            on
```

```
  Current setting:              off
```

NOTE: A save and reboot are required before turning dual-hash on or off.

```
  Dual-Hash Recursion Level:    1
```

The dual-hash information appears only on BlackDiamond 8800 series switches.

On BlackDiamond X8 switches, the following lines are added to the end of the output:

```
Fabric Hash Slot-1:
```

```
  Packet Algorithm:
```

```
    Dynamic mode
```

```
    Eligibility
```

or

```
Fabric Hash Slot-2:
```

```
  Packet Algorithm:
```

```
    crc16-ccitt
```

```
    seed: 0x12345678
```

or

```
Fabric Hash Slot-5:
```

```
  Source-port
```

When the switch fabric hash is set to Default, there is no printed output for the related slot.

Untagged Frames on the 10 Gbps Module

BlackDiamond 10808 Switch Only

On the BlackDiamond 10808 switch, the 10 Gbps module must have the serial number 804405-00-09 or higher to support untagged frames. To display the serial number of the module, use the `show slot <slot_number>` command. (All the modules for BlackDiamond 8800 series switches support tagged and untagged frames.)

Understanding the Error Reading Diagnostics Message

Summit Family Switches Only

If you have never run diagnostics on the switch or stack ports and use the `show diagnostics` command, the switch displays a message similar to the following:

```
Result: FAIL
      Test date run is invalid. Please run Diagnostics.
Error reading diagnostics information.
```

This message is normal and expected if you have never run diagnostics on the switch. After running diagnostics, you see information about the executed test using the `show diagnostics` command.

Running MSM/MM Diagnostics from the Bootloader

BlackDiamond 10808 and BlackDiamond 20800 Series Switches Only

If you experience problems with your MSM/MM module, or you are unable to use the `run diagnostics` command, you can enter the Bootloader and issue a series of commands to run diagnostics on the MSM/MM.

To access the Bootloader:

- 1 Attach a serial cable to the console port of the MSM/MM.
- 2 Attach the other end of the serial cable to a properly configured terminal or terminal emulator.
- 3 Reboot the MSM/MM and press the spacebar key on the keyboard of the terminal during the boot up process.



NOTE

You must press the spacebar key immediately after a power cycle of the MSM/MM in order to get into the Bootloader application.

As soon as you see the `BOOTLOADER>` prompt, release the key. From here, you can run the diagnostics on the MSM/MM.

To run diagnostics on the MSM/MM:

- 1 Identify the currently running software images by using the `show images` command.
- 2 Run diagnostics on the MSM by using the `boot [1-4]` command.

The numbers 1 through 4 correlate to specific images and diagnostics on the MSM:

- 1—XOS primary image
- 2—XOS secondary image
- 3—Diagnostics for image 1 (initiates diagnostics for the primary image)
- 4—Diagnostics for image 2 (initiates diagnostics for the secondary image)

For example, to run diagnostics on the primary image, use the following command:

```
boot 3
```

When the test is finished, the MSM reboots and runs the ExtremeXOS software.

Contacting Extreme Networks Technical Support

If you have a network issue that you are unable to resolve, contact Extreme Networks technical support. Extreme Networks maintains several Technical Assistance Centers (TACs) around the world to answer networking questions and resolve network problems.

You can contact technical support by phone at:

- (800) 998-2408
- (408) 579-2826

Or by email at:

- support@extremenetworks.com

You can also visit the support website at:

<http://www.extremenetworks.com/services/resources/>

From the support website, you can download software updates (requires a service contract) and documentation (including a .pdf version of this manual).

E

APPENDIX

Supported Standards, Protocols, and MIBs



NOTE

All information for supported standards and protocols has been moved to the following location: www.extremenetworks.com/go/datasheets. This appendix contains only the MIB support details.

MIB Support Details

The following sections describe the MIB support provided by the ExtremeXOS SNMP agent residing on Extreme Networks devices running ExtremeXOS:

- [Standard MIBs on page 1553](#)
- [Extreme Networks Proprietary MIBs on page 1587](#).

Where applicable, these sections note how the implementation differs from the standards or from the private MIBs.



NOTE

Only entries for the default VR are supported.



NOTE

ExtremeXOS software supports only the following “Row status” in the MIBs.

- Create and Go
 - Active
 - Destroy
-

Standard MIBs

The standard MIBs are described in the following sections:

- [IEEE 802.1AB \(LLDP-MIB\) on page 1554](#)

- IEEE 802.1AB (LLDP-EXT-DOT1-MIB) on page 1554
- IEEE 802.1AB (LLDP-EXT-DOT3-MIB) on page 1554
- IEEE 802.1AG (CFM MIB) on page 1555
- IEEE8021-PAE-MIB on page 1563
- IEEE8021X-EXTENSIONS-MIB on page 1564
- ISIS-MIB (draft-ietf-isis-wg-mib-10.txt) on page 1564
- PIM-MIB (draft-ietf-pim-mib-v2-01.txt) on page 1568
- SNMPv3 MIBs on page 1570
- RFC 1213 (MIB-II) on page 1571
- RFC 1215 on page 1571
- RFC 1493 (BRIDGE-MIB) and draft-ietf-bridge-rstpmib-03.txt on page 1571
- RFC 1724 (RIPv2-MIB) on page 1573
- RFC 1757 (RMON-MIB) on page 1573
- RFC 1850 (OSPF-MIB) on page 1574
- RFC 2021 (RMON2-MIB) on page 1574
- RFC 2233 (IF-MIB) on page 1574
- RFC 2465 (IPV6 MIB) on page 1576
- RFC 2466 (IPV6 ICMP MIB) on page 1576
- RFC 2613 (SMON) on page 1576
- RFC 2665 (EtherLike-MIB) on page 1579
- RFC 2668 (MAU-MIB) on page 1580
- RFC 2737 (ENTITY-MIB) on page 1582
- RFC 2787 (VRRP-MIB) on page 1583
- RFC 3621 (PoE-MIB) on page 1583
- RFC 5601 (PW-STD-MIB) on page 1584
- RFC 5602 (PW-MPLS-STD-MIB) on page 1585
- RFC 5603 (PW-ENET-STD-MIB) on page 1585
- VPLS-MIB (draft-ietf-l2vpn-vpls-mib-02.txt) on page 1586

IEEE 802.1AB (LLDP-MIB)

All tables and variables of this MIB are supported.

IEEE 802.1AB (LLDP-EXT-DOT1-MIB)

All tables and variables of this MIB are supported.

IEEE 802.1AB (LLDP-EXT-DOT3-MIB)

All tables and variables of this MIB are supported.

IEEE 802.1AG (CFM MIB)

This MIB contains objects for the 802.1ag protocol. The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
dot1agCfmMdTable	dot1agCfmMdIndex	The index to the Maintenance Domain (MD) table.
	dot1agCfmMdFormat	Supported as read only. The type (and thereby format) of the MD name.
	dot1agCfmMdName	Supported as read only. The MD name.
	dot1agCfmMdMdLevel	Supported as read only. The MD Level.
	dot1agCfmMdMhfCreation	Enumerated value indicating whether the management entity can create MHFs (MIP Half Function) for this MD. Supported as read only. Configuration in CLI is not supported. The <i>defMHFdefault (2)</i> value is returned.
	dot1agCfmMdMhfdPermission	Supported as read only. Configuration in CLI is not supported. The <i>sendIdChassisManage (4)</i> value is returned.
	dot1agCfmMdMaNextIndex	Value to be used as the index of the Maintenance Association (MA) table entries.
	dot1agCfmMdRowStatus	The status of the row. The writable columns in a row cannot be changed if the row is active. All columns must have a valid value before a row can be activated.
dot1agCfmMdTableNextIndex	dot1agCfmMdTableNextIndex	An unused value for dot1agCfmMdIndex that is used as the MD index for the next newly created domain.
dot1agCfmMaNetTable	dot1agCfmMdIndex	MD index.
	dot1agCfmMaIndex	Index of the MA table. dot1agCfmMdMaNextIndex needs to be inspected to find an available index for row-creation.
	dot1agCfmMaNetFormat	Supported as read only. The type of the MA name.
	dot1agCfmMaNetName	Supported as read only. MA name.
	dot1agCfmMaNetCcmInterval	Supported as read only. Transmission interval between CCMs to be used by all MEPs in the MA.

Table/Group	Supported Variables	Comments
	dot1agCfmMaNetRowStatus	The status of the row. The writable columns in a row cannot be changed if the row is active. All columns must have a valid value before a row can be activated.
dot1agCfmMepTable	dot1agCfmMdIndex	MD Index.
	dot1agCfmMaIndex	MA Index.
	dot1agCfmMepIdentifier	A small integer, unique over a given MA identifying a specific MA end point.
	dot1agCfmMepIfIndex	Supported as read only. Interface index of the interface bridge port.
	dot1agCfmMepDirection	Supported as read only. The direction in which the MEP faces on the bridge port.
	dot1agCfmMepPrimaryVid	Supported as read only. VID of the MEP.
	dot1agCfmMepActive	Supported as read only. Administrative state of the MEP.
	dot1agCfmMepFngState	Current state of the MEP Fault Notification Generator State Machine. Can have any one of the following values: <ul style="list-style-type: none"> • fngReset (1) • fngDefect (2) • fngReportDefect (3) • fngDefectReported (4) • fngDefectClearing (5)
	dot1agCfmMepCciEnabled	Supported as read only. If set to true, the MEP will generate CCM.
	dot1agCfmMepCcmLtmPriority	Supported as read only. The priority value for CCMs and LTMs transmitted by the MEP. Configuration in CLI is not supported. Default value 0 is returned.
	dot1agCfmMepMacAddress	MAC address of the MEP. In Extreme Networks switches, the <i>MAC</i> is returned.
	dot1agCfmMepLowPrDef	Supported as read only. An integer value specifying the lowest priority defect that is allowed to generate a Fault Alarm. Configuration in CLI is not supported. Default VLAN <i>macRemErrXon</i> is returned.
	dot1agCfmMepFngAlarmTime	Supported as read only. The time that defects must be present before a Fault Alarm is issued. Configuration in CLI is not supported. Default value 2.5 seconds is returned.

Table/Group	Supported Variables	Comments
	dot1agCfmMepFngResetTime	Supported as read only. The time that defects must be absent before resetting a Fault Alarm. Configuration in CLI is not supported. Default value 10 seconds is returned.
	dot1agCfmMepHighestPrDefect	The highest priority defect that has been present. Possible values are: <ul style="list-style-type: none"> • none (0) • defRDICCM (1) • defMACstatus (2) • defRemoteCCM (3) • defErrorCCM (4) • defXconCCM (5)
	dot1agCfmMepDefects	Error condition to be sent. The conditions can be any one of the following: <ul style="list-style-type: none"> • bDefRDICCM (0) • bDefMACstatus (1) • bDefRemoteCCM (2) • bDefErrorCCM (3) • bDefXconCCM (4)
	dot1agCfmMepErrorCcmLastFailure	The last-received CCM that triggered a DefErrorCCM fault.
	dot1agCfmMepXconCcmLastFailure	The last-received CCM that triggered a DefXconCCM fault.
	dot1agCfmMepCcmSequenceErrors	The total number of out-of-sequence CCMs received from all remote MEPs.
	dot1agCfmMepCciSentCcms	The total number of Continuity Check messages transmitted.
	dot1agCfmMepNextLbmTransId	Next sequence number/transaction identifier to be sent in a Loopback message.
	dot1agCfmMepLbrIn	The total number of valid, in-order Loopback Replies received.
	dot1agCfmMepLbrInOutOfOrder	The total number of valid, out-of-order Loopback Replies received.
	dot1agCfmMepLbrBadMsdu	The total number of LBRs received whose mac_service_data_unit did not match (except for the OpCode) that of the corresponding LBM.
	dot1agCfmMepLtmNextSeqNumber	Next transaction identifier/sequence number to be sent in a Linktrace message.

Table/Group	Supported Variables	Comments
	dot1agCfmMepUnexpLtrIn	The total number of unexpected LTRs received.
	dot1agCfmMepLbrOut	The total number of Loopback Replies transmitted.
	dot1agCfmMepTransmitLbmStatus	Supported as read only. A Boolean flag set to true by the bridge port to indicate that another LBM may be transmitted.
	dot1agCfmMepTransmitLbmDestMacAddress	Supported as read only. The target MAC address field to be transmitted.
	dot1agCfmMepTransmitLbmDestMepId	Supported as read only. To transmit the LBM, destMEPID need not be given.
	dot1agCfmMepTransmitLbmDestIsMepId	Supported as read only. This always returns <i>FALSE</i> .
	dot1agCfmMepTransmitLbmMessages	Supported as read only. The number of Loopback messages to be transmitted.
	dot1agCfmMepTransmitLbmDataTlv	Supported as read only. An arbitrary amount of data to be included in the Data TLV if the Data TLV is selected to be sent. This returns 0.
	dot1agCfmMepTransmitLbmVlanPriority	Priority. A three-bit value to be used in the VLAN tag, if present in the transmitted frame. Configuration in CLI is not supported. Default value 0 is returned.
	dot1agCfmMepTransmitLbmVlanDropEnable	Not supported. Returns <i>FALSE</i> .
	dot1agCfmMepTransmitLbmResultOK	Indicates the result of the operation linked with MEP active state.
	dot1agCfmMepTransmitLbmSeqNumber	The Loopback Transaction Identifier of the first LBM (to be) sent. The value returned is undefined if <i>dot1agCfmMepTransmitLbmResultOK</i> is false.
	dot1agCfmMepTransmitLtmStatus	Supported as read only. A Boolean flag set to true by the bridge port to indicate that another LTM may be transmitted.
	dot1agCfmMepTransmitLtmFlags	Supported as read only. The flags field for LTMs transmitted by the MEP. Currently, <i>useFDBOnly</i> (0) is supported.
	dot1agCfmMepTransmitLtmTargetMacAddress	Supported as read only. The target MAC address field to be transmitted.

Table/Group	Supported Variables	Comments
	dot1agCfmMepTransmitLtmTargetMepId	Not supported. To transmit the LTM <i>destMEPID</i> need not be given. Value 0 is returned.
	dot1agCfmMepTransmitLtmTargetIsMepId	Not supported. This always returns <i>FALSE</i> .
	dot1agCfmMepTransmitLtmTtl	Supported as read only. The LTM TTL field.
	dot1agCfmMepTransmitLtmResult	Supported as read only. Indicates the result of the operation. Linked with MEP active state.
	dot1agCfmMepTransmitLtmSeqNumber	The LTM transaction identifier.
	dot1agCfmMepTransmitLtmEgressIdentifier	Supported as read only. Identifies the MEP Linktrace Initiator that is originating or the Linktrace Responder that is forwarding this LTM.
	dot1agCfmMepRowStatus	The status of the row. The writable columns in a row cannot be changed if the row is active. All columns must have a valid value before a row can be activated.
dot1agCfmMepDbTable	dot1agCfmMdIndex	MD Index.
	dot1agCfmMaIndex	MA Index.
	dot1agCfmMepIdentifier	MA end point identifier.
	dot1agCfmMepDbRMepIdentifier	Maintenance association end point identifier of a remote MEP whose information from the MEP database is to be returned.
	dot1agCfmMepDbRMepState	The operational state of the remote MEP IFF state machines. The state can be any one of the following: <ul style="list-style-type: none"> • rMepIdle (1) • rMepStart (2) • rMepFailed (3) • rMepOk (4)
	dot1agCfmMepDbRMepFailedOkTime	The time (SysUpTime) at which the IFF remote MEP state machine last entered either the RMEP_FAILED or RMEP_OK state.
	dot1agCfmMepDbMacAddress	The MAC address of the remote MEP.
	dot1agCfmMepDbRdi	State of the RDI bit in the last received CCM.

Table/Group	Supported Variables	Comments
	dot1agCfmMepDbPortStatusTlv	An enumerated value of the Port status TLV received in the last CCM from the remote MEP or the default value. The value is one of the following: <ul style="list-style-type: none"> psNoPortStateTLV (0) psBlocked (1) psUp (2)
	dot1agCfmMepDbInterfaceStatusTlv	An enumerated value of the Interface status TLV received in the last CCM from the remote MEP. The value can be one of the following: <ul style="list-style-type: none"> isNoInterfaceStatusTLV (0) isUp (1) isDown (2) isTesting (3) isUnknown (4) isDormant (5) isNotPresent (6) isLowerLayerDown (7)
	dot1agCfmMepDbChassisIdSubtype	<i>networkAddress</i> (5) is returned if senderIDTLV is received.
	dot1agCfmMepDbChassisId	The first octet contains the IANA Address Family Numbers enumeration value for the specific address type, and octets 2 through N contain the network address value in network byte order.
	dot1agCfmMepDbManAddressDomain	Not supported. Value <i>zero</i> is returned.
	dot1agCfmMepDbManAddress	Not supported. Value <i>zero</i> is returned.
dot1agCfmLtrTable	dot1agCfmMdIndex	MD Index.
	dot1agCfmMaIndex	MA Index.
	dot1agCfmMepIdentifier	MA end point identifier.
	dot1agCfmLtrSeqNumber	Transaction identifier/sequence number returned by a previous transmit linktrace message command.
	dot1agCfmLtrReceiveOrder	An index to distinguish among multiple LTRs with the same LTR Transaction Identifier field value.
	dot1agCfmLtrTtl	TTL field value for a returned LTR.
	dot1agCfmLtrForwarded	Indicates if a LTM was forwarded by the responding MP.

Table/Group	Supported Variables	Comments
	dot1agCfmLtrTerminalMep	Not supported. Value <i>FALSE</i> is returned.
	dot1agCfmLtrLastEgressIdentifier	An octet field holding the Last Egress Identifier returned in the LTR Egress Identifier TLV of the LTR.
	dot1agCfmLtrNextEgressIdentifier	An octet field holding the Next Egress Identifier returned in the LTR Egress Identifier TLV of the LTR.
	dot1agCfmLtrRelay	Value returned in the Relay Action field.
	dot1agCfmLtrChassisIdSubtype	<i>networkAddress</i> (5) is returned if senderIDTLV is received.
	dot1agCfmLtrChassisId	The first octet contains the IANA Address Family Numbers enumeration value for the specific address type, and octets 2 through N contain the network address value in network byte order.
	dot1agCfmLtrManAddressDomain	Not supported. Value <i>zero</i> is returned.
	dot1agCfmLtrManAddress	Not supported. Value <i>zero</i> is returned.
	dot1agCfmLtrIngress	The value returned in the Ingress Action Field of the LTM.
	dot1agCfmLtrIngressMac	MAC address returned in the ingress MAC address field.
	dot1agCfmLtrIngressPortIdSubtype	<i>interfaceName</i> (5) is returned if present.
	dot1agCfmLtrIngressPortId	<i>interfaceName</i> (5), then the octet string identifies a particular instance of the ifName object. If the particular ifName object does not contain any values, another port identifier type should be used.
	dot1agCfmLtrEgress	The value returned in the Egress Action Field of the LTM.
	dot1agCfmLtrEgressMac	MAC address returned in the egress MAC address field.
	dot1agCfmLtrEgressPortIdSubtype	<i>interfaceName</i> (5) is returned if present.
	dot1agCfmLtrEgressPortId	<i>interfaceName</i> (5), then the octet string identifies a particular instance of the ifName object. If the particular ifName object does not contain any values, another port identifier type should be used.

Table/Group	Supported Variables	Comments
	dot1agCfmLtrOrganizationSpecificTlv	All organization specific TLVs returned in the LTR.
dot1agCfmStackTable	dot1agCfmStackIfIndex	Index object. This object represents the bridge port or aggregated port on which MEPs or MHFs might be configured.
	dot1agCfmStackVlanIdOrNone	Index object. VLAN ID to which the MP is attached.
	dot1agCfmStackMdLevel	Index object. MD Level of the Maintenance Point.
	dot1agCfmStackDirection	Index object. Direction in which the MP faces on the bridge port.
	dot1agCfmStackMdIndex	The index of the MD in the dot1agCfmMdTable to which the MP is associated.
	dot1agCfmStackMaIndex	The index of the MA in the dot1agCfmMaNetTable and dot1agCfmMaCompTable to which the MP is associated.
	dot1agCfmStackMepId	If an MEP is configured, the MEP ID.
	dot1agCfmStackMacAddress	MAC address of the MP.
dot1agCfmMaMepListTable	dot1agCfmMdIndex	MD Index.
	dot1agCfmMaIndex	MA Index.
	dot1agCfmMaMepListIdentifier	MEP identifier.
	dot1agCfmMaMepListRowStatus	

Table/Group	Supported Variables	Comments
dot1agCfmFaultAlarm (NOTIFICATION)	dot1agCfmMepHighestPrDefect	<p>A MEP has a persistent defect condition. A notification (fault alarm) is sent to the management entity with the OID of the MEP that has detected the fault.</p> <p>The management entity receiving the notification can identify the system from the network source address of the notification, and can identify the MEP reporting the defect by the indices in the OID of the dot1agCfmMepHighestPrDefect variable in the notification:</p> <ul style="list-style-type: none"> dot1agCfmMdIndex—Also the index of the MEPs. MD table entry (dot1agCfmMdTable). dot1agCfmMaIndex—Also an index (with the MD table index) of the MEP's MA network table entry (dot1agCfmMaNetTable), and (with the MD table index and component ID) of the MEP's MA component table entry. dot1agCfmMepIdentifier—MEP Identifier and final index into the MEP table (dot1agCfmMepTable).
dot1agCfmMaCompTable		Not supported
dot1agCfmConfigErrorList Table		Not supported
dot1agCfmVlanTable		Not supported
dot1agCfmDefaultMdTable		Not supported

IEEE8021-PAE-MIB

This MIB contains objects for the 802.1X protocol draft D10 of the 802.1X standard. The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
dot1xPaeSystemAuthControl		
dot1xPaePortTable	All objects	
dot1xAuthConfigTable	Not supported	In lieu of these tables, Extreme Networks supports the per-station based versions which are present in the IEEE8021X- EXTENSIONS-MIB.
dot1xAuthStatsTable	Not supported	
dot1xAuthDiagTable	Not supported	This table has been deprecated in the drafts subsequent to the 2001 version of the 802.1X standard.

Table/Group	Supported Variables	Comments
dot1xAuthSessionStatsTable	Not supported	
dot1xSuppConfigTable	None	These tables are not applicable to the switch since they are for a supplicant.
dot1xSuppStatsTable	None	

IEEE8021X-EXTENSIONS-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
dot1xAuthStationTable	All objects	
dot1xAuthConfigTable	All objects	
dot1xAuthStatsTable	All objects	

ISIS-MIB (draft-ietf-isis-wg-mib-10.txt)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
IsisSysTable	isisSysInstance	
	isisSysVersion	
	isisSysType	
	isisSysID	
	isisSysMaxPathSplits	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisSysMaxLSPGenInt	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisSysMaxAreaAddresses	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisSysPollESHHelloRate	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisSysWaitTime	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisSysAdminState	
	isisSysLogAdjacencyChanges	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisSysNextCirclIndex	
	isisSysL2toL1Leaking	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisSysMaxAge	
	isisSysReceiveLSPBufferSize	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisSysExistState	Only state <i>destroy</i> (6) is supported.
isisSysLevelTable	isisSysLevelIndex	

Table/Group	Supported Variables	Comments
	isisSysLevelOrigLSPBuffSize	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisSysLevelMinLSPGenInt	Supported isisSysLevelMinLSPGenInt range is 1 - 120 (MIB is 1 - 65535).
	isisSysLevelOverloadState	
	isisSysLevelSetOverload	
	isisSysLevelSetOverloadUntil	
	isisSysLevelMetricStyle	
	isisSysLevelSPFConsiders	
isisManAreaAddrTable	isisManAreaAddr	
	isisManAreaAddrExistState	
isisAreaAddrTable	isisAreaAddr	isisAreaAddrTable only displays the contents of the isisManAreaAddrTable.
isisSysProtSuppTable	isisSysProtSuppProtocol	
	isisSysProtSuppExistState	Supported as read-only.
isisSummAddrTable	isisSummAddressType	
	isisSummAddress	
	isisSummAddrPrefixLen	
	isisSummAddrExistState	
	isisSummAddrMetric	Supported as read-only.
	isisSummAddrFullMetric	Supported as read-only.
isisCircTable	isisCircIndex	
	isisCircIfIndex	Supported as read-only.
	isisCircIfSubIndex	Supported as read-only.
	isisCircAdminState	Setting isisCircAdminState to <i>off</i> (2) deletes the entry.
	isisCircExistState	Only state <i>destroy</i> (6) is supported.
	isisCircType	Only <i>broadcast</i> (1) and <i>ptToPt</i> (2) are supported for isisCircType.
	isisCircExtDomain	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisCircLevel	
	isisCircPassiveCircuit	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisCircMeshGroupEnabled	
	isisCircMeshGroup	
	isisCircSmallHellos	
	isisCircLastUpTime	
	isisCirc3WayEnabled	Supported as read-only.
isisCircLevelTable	isisCircLevelIndex	
	isisCircLevelMetric	Supported isisCircLevelMetric range is 1 - 63 (MIB is 0 - 63).

Table/Group	Supported Variables	Comments
	isisCircLevelWideMetric	Supported isisCircLevelMetricWide range is 1 - 16777214 (MIB is 0 - 16777214).
	isisCircLevelSPriority	
	isisCircLevelIDOctet	Supported as read-only.
	isisCircLevelID	
	isisCircLevelDesIS	
	isisCircLevelHelloMultiplier	Default isisCircLevelHelloMultiplier is 3 (MIB is 10).
	isisCircLevelHelloTimer	Default isisCircLevelHelloTimer is 10000 ms (MIB is 3000 ms). Supported range is 1000 - 600000 ms (MIB is 10 - 600000 ms). Fractions of a second are rounded to the nearest whole second.
	isisCircLevelDRHelloTimer	Supported as read-only. isisCircLevelDRHelloTimer object is computed as 1/3 of isisCircLevelHelloTimer.
	isisCircLevelLSPThrottle	Default isisCircLevelLSPThrottle is 33 ms (MIB is 30 ms).
	isisCircLevelMinLSPRetransInt	
	isisCircLevelCSNPInterval	
	isisCircLevelPartSNPInterval	Unsupported object. Always returns MIB default value if one exists for a GET.
isisSystemCounterTable	isisSysStatLevel	
	isisSysStatCorrLSPs	
	isisSysStatAuthTypeFails	
	isisSysStatAuthFails	
	isisSysStatLSPDbaseOloads	
	isisSysStatManAddrDropFromAreas	
	isisSysStatAttmptToExMaxSeqNums	
	isisSysStatSeqNumSkips	
	isisSysStatOwnLSPPurges	
	isisSysStatIDFieldLenMismatches	
	isisSysStatMaxAreaAddrMismatches	
	isisSysStatPartChanges	
	isisSysSPFRuns	
isisCircuitCounterTable	isisCircuitType	
	isisCircAdjChanges	
	isisCircNumAdj	
	isisCircInitFails	
	isisCircRejAdjs	
	isisCircIDFieldLenMismatches	
	isisCircMaxAreaAddrMismatches	
	isisCircAuthTypeFails	

Table/Group	Supported Variables	Comments
	isisCircAuthFails	
	isisCircLANDesISChanges	
isisPacketCounterTable	isisPacketCountLevel	
	isisPacketCountDirection	
	isisPacketCountIIHello	
	isisPacketCountISHello	
	isisPacketCountESHello	
	isisPacketCountLSP	
	isisPacketCountCSNP	
	isisPacketCountPSNP	
	isisPacketCountUnknown	
isisSAdjTable	isisSAdjIndex	
	isisSAdjState	
	isisSAdj3WayState	
	isisSAdjNeighSNPAAAddress	
	isisSAdjNeighSysType	
	isisSAdjNeighSysID	
	isisSAdjExtendedCircID	
	isisSAdjUsage	
	isisSAdjHoldTimer	
	isisSAdjNeighPriority	
	isisSAdjLastUpTime	
isisSAdjAreaAddrTable	isisSAdjAreaAddrIndex	
	isisSAdjAreaAddress	
isisSAdjIPAddrTable	isisSAdjIPAddrIndex	
	isisSAdjIPAddressType	
	isisSAdjIPAddress	
isisSAdjProtSuppTable	isisSAdjProtSuppProtocol	
isisPRATable	isisPRAIndex	
	isisPRADestType	
	isisPRADest	
	isisPRADestPrefixLen	
	isisPRANextHopType	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisPRANextHop	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisPRAType	Supported as read-only.
	isisPRAExistState	Unsupported object. Always returns MIB default value if one exists for a GET.

Table/Group	Supported Variables	Comments
	isisIPRAAdminState	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisPRAMetric	Supported as read-only.
	isisPRAMetricType	Supported as read-only.
	isisPRAFullMetric	Supported as read-only.
	isisPRASNPAAddress	Unsupported object. Always returns MIB default value if one exists for a GET.
	isisPRASourceType	
isisLSPSummaryTable	isisLSPLevel	
	isisLSPId	
	isisLSPSeq	
	isisLSPZeroLife	
	isisLSPChecksum	
	isisLSPLifetimeRemain	
	isisLSPPDULength	
	isisLSPAttributes	
isisLSPTLVTable	isisLSPTLVIndex	
	isisLSPTLVSeq	
	isisLSPTLVChecksum	
	isisLSPTLVType	
	isisLSPTLVLen	
	isisLSPTLVValue	

PIM-MIB (draft-ietf-pim-mib-v2-01.txt)

This MIB is superset of RFC 2934.

Table/Group	Supported Variables	Comments
pimInterfaceTable	pimInterfaceIndex	
	pimInterfaceAddress	
	pimInterfaceNetMask	
	pimInterfaceMode	
	pimInterfaceDR	
	pimInterfaceHelloInterval	
	pimInterfaceStatus	
	pimInterfaceJoinPruneInterval	
	pimInterfaceCBSRPreference	
	pimInterfaceTrigHelloInterval	Not supported.

Table/Group	Supported Variables	Comments
	pimInterfaceHelloHoldtime	These objects are supported as read only.
	pimInterfaceLanPruneDelay	
	pimInterfacePropagationDelay	
	pimInterfaceOverrideInterval	
	pimInterfaceGenerationID	
	pimInterfaceJoinPruneHoldtime	
	pimInterfaceGraftRetryInterval	
	pimInterfaceMaxGraftRetries	
	pimInterfaceSRTTLThreshold	
	pimInterfaceLanDelayEnabled	
	pimInterfaceSRCapable	
	pimInterfaceDRPriority	This object is supported as read only.
pimNeighborTable	pimNeighborAddress	
	pimNeighborIfIndex	
	pimNeighborUpTime	
	pimNeighborExpiryTime	
	pimNeighborMode	Feature unsupported, only default value is returned.
	pimNeighborLanPruneDelay	Feature unsupported, only default value is returned.
	pimNeighborOverrideInterval	
	pimNeighborTBit	Feature unsupported so only default value is returned.
	pimNeighborSRCapable	Feature unsupported so only default value is returned.
	pimNeighborDRPresent	Feature unsupported so only default value is returned.
pimIpMRouteTable	pimIpMRouteUpstreamAssertTimer	
	pimIpMRouteAssertMetric	
	pimIpMRouteAssertMetricPref	
	pimIpMRouteAssertRPTBit	
	pimIpMRouteFlags	
	pimIpMRouteRPFNeighbor	
	pimIpMRouteSourceTimer	
	pimIpMRouteOriginatorSRTTL	Feature unsupported so only default value is returned.
pimIpMRouteNextHopTable	pimIpMRouteNextHopPruneReason	
	pimIpMRouteNextHopAssertWinner	
	pimIpMRouteNextHopAssertTimer	
	pimIpMRouteNextHopAssertMetric	Not supported.
	pimIpMRouteNextHopAssertMetricPref	Not supported.

Table/Group	Supported Variables	Comments
	pimIpMRouteNextHopJoinPruneTimer	Not supported.
pimRPSetTable	pimRPSetGroupAddress	
	pimRPSetGroupMask	
	pimRPSetAddress	
	pimRPSetHoldTime	
	pimRPSetExpiryTime	
	pimRPSetComponent	
pimCandidateRPTable	pimCandidateRPGroupAddress	
	pimCandidateRPGroupMask	
	pimCandidateRPAddress	
	pimCandidateRPRowStatus	
pimComponentTable	pimComponentIndex	
	pimComponentBSRAddress	
	pimComponentBSRExpiryTime	
	pimComponentCRPHoldTime	This object is supported as read only.
	pimComponentStatus	
Scalars	pimJoinPruneInterval	
	pimSourceLifetime	State Refresh feature is not supported, so these variables are set to defaults.
	pimStateRefreshInterval	
	pimStateRefreshLimitInterval	
	pimStateRefreshTimeToLive	
PIM Traps	pimNeighborLoss	Not supported.

SNMPv3 MIBs

The ExtremeXOS SNMP stack fully supports the SNMPv3 protocol and therefore implements the MIBs in the SNMPv3 RFCs. Specifically, the MIBs in following RFCs are fully supported:

- RFC 2576—*Coexistence between Version 1, Version 2, and Version 3 of the Internet-standard Network Management Framework*
- RFC 3410—*Introduction and Applicability Statements for Internet-Standard Management Framework*
- RFC 3411—*An Architecture for Describing Simple Network Management Protocol (SNMP) Management Frameworks*
- RFC 3412—*Message Processing and Dispatching for the Simple Network Management Protocol (SNMP)*
- RFC 3413—*Simple Network Management Protocol (SNMP) Applications.*
- RFC 3414—*User-based Security Model (USM) for version 3 of the Simple Network Management Protocol (SNMPv3)*
- RFC 3415—*View-based Access Control Model (VACM) for the Simple Network Management Protocol (SNMP)*
- RFC 3826—*The Advanced Encryption Standard (AES) Cipher Algorithm in the SNMP User-based Security Model*

RFC 1213 (MIB-II)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
System group scalars	All objects	The sysServices object always returns the value 79.
Interfaces group		Supported as per RFC 2233.
IP Group scalars	All objects	
ipAddrTable	All objects	
ipRouteTable	All objects	Supported as read only. Routes are indexed by prefix only.
ipNetToMediaTable	All objects	
ICMP group	All objects	
TCP group scalars	All objects	
tcpConnTable	All objects	
UDP group scalars	All objects	
udpTable	All objects	
EGP Group	Not supported	
SNMP group	All objects	
At group	All objects	Supported as read only.

RFC 1215

This MIB defines an SMI for SNMPv1 traps, and some traps themselves. Of these, the following are supported.

Traps	Comments
coldStart	The system cannot distinguish between a cold and warm reboot, so the warmStart trap is always sent. This is the same behavior as in ExtremeWare.
warmStart	
authenticationFailure	
linkDown	
linkUp	

RFC 1493 (BRIDGE-MIB) and draft-ietf-bridge-rstpmib-03.txt

The BRIDGE-MIB has been augmented with draft-ietf-bridge-rstpmib-03.txt for 802.1w support. Objects below that are defined in the latter are marked as such.

Table/Group	Supported Variables	Comments
dot1dBase group scalars	dot1dBaseBridgeAddress	
	dot1dBaseNumPorts	This object returns the number of ports in STP domain <i>s0</i> , not the total number of ports on the switch.
	dot1dBaseType	

Table/Group	Supported Variables	Comments
dot1dBasePortTable	Partial	dot1dBasePortIfIndex is supported. dot1dBasePortCircuit always has the value { 0 0 } since there is a one to one correspondence between a physical port and its ifIndex. dot1dBasePortDelayExceededDiscards and dot1dBasePortMtuExceededDiscards are not supported and always return 0.
dot1dStp group scalars	dot1dStpProtocolSpecification	Values for these objects will be returned for the STP domain s0 only. For other domains, see the EXTREME-STPEXTENSTIONS-MIB.
	dot1dStpPriority	
	dot1dStpTimeSinceTopologyChange	
	dot1dStpTopChanges	
	dot1dStpDesignatedRoot	
	dot1dStpRootCost	
	dot1dStpRootPort	
	dot1dStpMaxAge	
	dot1dStpHelloTime	
	dot1dStpHoldTime	
	dot1dStpForwardDelay	
	dot1dStpBridgeMaxAge	
	dot1dStpBridgeHelloTime	
	dot1dStpBridgeForwardDelay	
	dot1dStpVersion	This object is not present in the original RFC1493, but is defined in the Internet draft <i>draft-ietf-bridge-rstp-mib-03.txt</i> .
	dot1dStpTxHoldCount	This object is not present in the original RFC1493, but is defined in the Internet draft <i>draft-ietf-bridge-rstp-mib-03.txt</i> . This object not supported; it always returns a value of (1). Attempting to set it yields an error.
	dot1dStpPathCostDefault	This object is not present in the original RFC1493, but is defined in the Internet draft <i>draft-ietf-bridge-rstp-mib-03.txt</i> . For this object only 8021d1998 (1) is supported at this time, not stp802112001 (2). Attempting to set (2) yields an error.
dot1dStpExtPortTable	All objects	This object is not present in the original RFC1493, but is defined in the Internet draft <i>draft-ietf-bridge-rstp-mib-03.txt</i> . The object 'dot1dStpPortProtocolMigration' is not supported; it always returns a value of (2). Attempting to set it yields an error.
dot1dStpPortTable	All objects	
STP Traps	newRoot	
	topologyChange	

Table/Group	Supported Variables	Comments
dot1dTpFdbTable	Supported	The object dot1dTpFdbTable displays ports and FDB MAC addresses. They include both the static and dynamic FDB entries on the switch. The MIB does not provide a way to identify the VLAN on which the entry was learned. The port numbers are assumed to be 1 to 128 on Slot 1, and 128 to 255 on Slot 2, etc. (that is, with a total of 128 ports on each of the slots on a chassis system).
dot1dTpPortTable	Supported	
dot1dStatic group	Supported	
	Dot1dStaticAllowedToGoTo	Not supported

RFC 1724 (RIPv2-MIB)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
rip2Globals	rip2GlobalRouteChanges	
	rip2GlobalQueries	
rip2IfStatTable	All objects	
rip2IfConfTable	All objects	
rip2PeerTable	Not supported	

RFC 1757 (RMON-MIB)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
etherStatsTable	All objects, except etherStatsDropEvents	
historyControlTable	All objects	
etherHistoryTable	All objects, except etherHistoryDropEvents	
alarmTable	All objects	
eventTable	All objects	
logTable	All objects	

RFC 1850 (OSPF-MIB)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
ospfGeneralGroup	All objects	
ospfAreaTable	All objects	
ospfStubAreaTable	All objects	
ospfLsdbTable	All objects	
ospfAreaRangeTable	All objects	
ospfHostTable	All objects	
ospfIfTable	All objects	
ospfIfMetricTable	All objects	
ospfVirtIfTable	All objects	
ospfNbrTable	All objects	
ospfVirtNbrTable	All objects	
ospfExtLsdbTable	All objects	
ospfAreaAggregateTable	All objects	
ospfTrap	All traps	

RFC 2021 (RMON2-MIB)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
	probeCapabilities	
	probeSoftwareRev	
	probeHardwareRev	
	probeDateTime	
	probeResetControl	
trapDestTable	All objects	

RFC 2233 (IF-MIB)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
	IfNumber	
ifTable	ifIndex	The ifIndex for ports is calculated as ((slot * 1000) + port). For VLANs, the ifIndex starts from 1000001.
	ifDescr	
	ifType	Only the following values are supported: {other, ethernetCsmacd, softwareLoopback, propVirtual}
	ifMtu	

Table/Group	Supported Variables	Comments
	ifSpeed	
	ifPhysAddress	
	ifAdminStatus	The testing state is not supported.
	ifOperStatus	
	ifLastChange	
	ifInOctets	Updated every time SNMP queries this counter.
	ifInUcastPkts	Updated every time SNMP queries this counter.
	IfInNUcastPkts(deprecated)	Though deprecated, this object returns a value if the system keeps a count. Updated every time SNMP queries this counter.
	ifInDiscards	No count is kept of this object, so it always returns 0.
	ifInErrors	Updated every time SNMP queries this counter.
	ifInUnknownProtos	No count is kept of this object, so it always returns 0.
	ifOutOctets	Updated every time SNMP queries this counter.
	ifOutUcastPkts	Updated every time SNMP queries this counter.
	IfOutNUcastPkts(deprecated)	Though deprecated, this object returns a value if the system keeps a count. Updated every time SNMP queries this counter.
	ifOutDiscards	No count is kept of this object, so it always returns 0.
	ifOutErrors	Updated every time SNMP queries this counter.
	IfOutQLen(deprecated)	Though deprecated, this object will returns a value if the system keeps a count. Updated every time SNMP queries this counter.
	IfSpecific	Not implemented. Always returns <i>iso.org.dod.internet</i> .
ifXTable	All objects	Only port interfaces return non-zero values for the counter objects in this table. The object <i>ifPromiscuousMode</i> is supported as read-only. <i>ifCounterDiscontinuityTime</i> is not implemented. All the statistics counters in the ifXTable are updated every time SNMP queries them.
ifStackTable	Not supported	
IfTestTable	Not supported	
ifRcvAddressTable	All objects	<i>ifRcvAddressTable</i> is supported as read-only. Also, only entries for physical ports appear in it.
snmpTraps	linkDown	
	linkUp	

RFC 2465 (IPV6 MIB)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
ipv6Forwarding	All objects	
ipv6DefaultHopLimit	All objects	
ipv6Interfaces	All objects	
ipv6IfTableLastChange	All objects	
ipv6IfTable	All objects except ipv6IfEffectiveMtu	
ipv6IfStatsTable	All objects	
ipv6AddrPrefixTable	All objects	
ipv6AddrTable	All objects	
ipv6RouteNumber	All objects	
ipv6DiscardedRoutes	All objects	
ipv6RouteTable	All objects	
ipv6NetToMediaTable	All objects	

RFC 2466 (IPV6 ICMP MIB)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
ipv6IflcmpTable	All objects	

RFC 2613 (SMON)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
smonVlanStatsControlTable	smonVlanStatsControlIndex	A unique arbitrary index for this smonVlanStatsControlEntry.
	smonVlanStatsControlDataSource	The source of data for this set of VLAN statistics. This object MAY NOT be modified if the associated smonVlanStatsControlStatus object is equal to <i>active</i> (1).
	smonVlanStatsControlCreateTime	The value of sysUpTime when this control entry was last activated. This object allows a management station to detect deletion and recreation cycles between polls.
	smonVlanStatsControlOwner	Administratively assigned named of the owner of this entry. It usually defines the entity that created this entry and is therefore using the resources assigned to it, though there is no enforcement mechanism, nor assurance that rows created are ever used.

Table/Group	Supported Variables	Comments
	smonVlanStatsControlStatus	The status of this row. An entry MAY NOT exist in the active state unless all objects in the entry have an appropriate value. If this object is not equal to <i>active</i> (1), all associated entries in the smonVlanIdStatsTable SHALL be deleted.
smonVlanIdStatsTable	smonVlanIdStatsId	The unique identifier of the VLAN monitored for this specific statistics collection. Tagged packets match the VID for the range between 1 and 4094. An external RMON probe MAY detect VID=0 on an Inter Switch Link, in which case the packet belongs to a VLAN determined by the PVID of the ingress port. The VLAN to which such a packet belongs can be determined only by a RMON probe internal to the switch.
	smonVlanIdStatsTotalPkts	The total number of packets counted on this VLAN.
	smonVlanIdStatsTotalOverflowPkts	The number of times the associated smonVlanIdStatsTotalPkts counter has overflowed.
	smonVlanIdStatsTotalHCPkts	The total number of packets counted on this VLAN.
	smonVlanIdStatsTotalOctets	The total number of octets counted on this VLAN.
	smonVlanIdStatsTotalOverflowOctets	The number of times the associated smonVlanIdStatsTotalOctets counter has overflowed.
	smonVlanIdStatsTotalHCOctets	The total number of octets counted on this VLAN.
	smonVlanIdStatsNUcastPkts	The total number of non-unicast packets counted on this VLAN.
	smonVlanIdStatsNUcastOverflowPkts	The number of times the associated smonVlanIdStatsNUcastPkts counter has overflowed.
	smonVlanIdStatsNUcastHCPkts	The total number of non-unicast packets counted on this VLAN.
	smonVlanIdStatsNUcastOctets	The total number of non-unicast octets counted on this VLAN.
	smonVlanIdStatsNUcastOverflowOctets	The number of times the associated smonVlanIdStatsNUcastOctets counter has overflowed.
	smonVlanIdStatsNUcastHCOctets	The total number of Non-unicast octets counted on this VLAN.
	smonVlanIdStatsCreateTime	The value of sysUpTime when this entry was last activated. This object allows a management station to detect deletion and recreation cycles between polls.
dataSourceDapsTable	dataSourceCapsObject	Defines an object that can be a SMON data source or a source or a destination for a port copy operation.

Table/Group	Supported Variables	Comments
	dataSourceRmonCaps	General attributes of the specified dataSource. Note that these are static attributes, which SHOULD NOT be adjusted because of current resources or configuration.
	dataSourceCopyCaps	PortCopy function capabilities of the specified dataSource. Note that these are static capabilities, which SHOULD NOT be adjusted because of current resources or configuration.
	dataSourceCapsIfIndex	This object contains the ifIndex value of the ifEntry associated with this smonDataSource. The agent MUST create 'propVirtual' ifEntries for each dataSourceCapsEntry of type VLAN or entPhysicalEntry.
portCopyConfigTable	portCopySource	The ifIndex of the source which has all packets redirected to the destination as defined by portCopyDest.
	portCopyDest	Defines the ifIndex destination for the copy operation.
	portCopyDestDropEvents	The total number of events in which port copy packets were dropped by the switch at the destination port due to lack of resources. Note that this number is not necessarily the number of packets dropped; it is just the number of times this condition has been detected. A single dropped event counter is maintained for each portCopyDest. Thus all instances associated with a given portCopyDest will have the same portCopyDestDropEvents value. The value for this field is "0" (zero) due to hardware limitation.
	portCopyDirection	This object affects the way traffic is copied from a switch source port, for the indicated port copy operation. If this object has the value <i>copyRxOnly</i> (1), then only traffic received on the indicated source port will be copied to the indicated destination port. If this object has the value <i>copyTxOnly</i> (2), then only traffic transmitted out the indicated source port will be copied to the indicated destination port. If this object has the value <i>copyBoth</i> (3), then all traffic received or transmitted on the indicated source port will be copied to the indicated destination port. The creation and deletion of instances of this object is controlled by the portCopyRowStatus object. Note that there is no guarantee that changes in the value of this object performed while the associated portCopyRowStatus object is equal to active will not cause traffic discontinuities in the packet.

Table/Group	Supported Variables	Comments
	portCopyStatus	Defines the status of the port copy entry. In order to configure a source to destination portCopy relationship, both source and destination interfaces MUST be present as an ifEntry in the ifTable and their respective ifAdminStatus and ifOperStatus values must be equal to <i>up</i> (1). If the value of any of those two objects changes after the portCopyEntry is activated, portCopyStatus transitions to <i>notReady</i> (3). The capability of an interface to be source or destination of a port copy operation is described by the <i>copySourcePort</i> (0) and <i>copyDestPort</i> (1) bits in <i>dataSourceCopyCaps</i> . Those bits should be appropriately set by the agent, in order to allow for a portCopyEntry to be created.
smonPrioStatsControlTable		Not supported due to hardware limitations.
smonPrioStatsTable		

RFC 2665 (EtherLike-MIB)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
Dot3StatsTable	dot3StatsIndex	
	dot3StatsAlignmentErrors	
	dot3StatsFCSErrors	
	dot3StatsSingleCollisionFrames	
	dot3StatsMultipleCollisionFrames	
	dot3StatsSQETestErrors	Not supported
	dot3StatsDeferredTransmissions	
	dot3StatsLateCollisions	
	dot3StatsExcessiveCollisions	
	dot3StatsInternalMacTransmitErrors	
	dot3StatsCarrierSenseErrors	Not supported
	dot3StatsFrameTooLongs	
	dot3StatsInternalMacReceiveErrors	
	dot3StatsSymbolErrors	Not supported
	dot3StatsEtherChipSet	
	dot3StatsDuplexStatus	
dot3CollTable	dot3CollCount	
	dot3CollFrequencies	
dot3ControlTable		Not supported
dot3PauseTable		Not supported

Other Unsupported Tables and Nodes in EtherLike MIB: dot3ControlTable, dot3PauseTable, dot3Tests – all nodes under this, dot3Errors, etherConformance, etherGroups, etherCompliance, dot3Compliance. RFC 1657 (Definitions of Managed Objects for the Fourth Version of the Border Gateway Protocol (BGP-4) using SMIV2).

All tables and variables of this MIB are supported with read-only access.

RFC 2668 (MAU-MIB)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
ifMauTable	All objects	
ifJackTable	All objects	
ifMauAutoNegTable	All objects	Setting auto-negotiation through SNMP is not supported.

The following new Extreme proprietary MAU types have been added to the ifMauType textual convention:

```

extremeMauType1000BaseWDMHD OBJECT IDENTIFIER
 ::= { extremeMauType 7 }
      "Gigabit WDM, half duplex"
extremeMauType1000BaseWDMFD OBJECT IDENTIFIER
 ::= { extremeMauType 8 }
      "Gigabit WDM, full duplex"
extremeMauType1000BaseLX70HD OBJECT IDENTIFIER
 ::= { extremeMauType 9 }
      "Gigabit LX70, half duplex"
extremeMauType1000BaseLX70FD OBJECT IDENTIFIER
 ::= { extremeMauType 10 }
      "Gigabit LX70, full duplex"
extremeMauType1000BaseZXHD OBJECT IDENTIFIER
 ::= { extremeMauType 11 }
      "Gigabit ZX, half duplex"
extremeMauType1000BaseZXFD OBJECT IDENTIFIER
 ::= { extremeMauType 12 }
      "Gigabit ZX, full duplex"
extremeMauType1000BaseLX100HD OBJECT IDENTIFIER
 ::= { extremeMauType 13 }
      "Gigabit LX100, half duplex"
extremeMauType1000BaseLX100FD OBJECT IDENTIFIER
 ::= { extremeMauType 14 }
      "Gigabit LX100, full duplex"
extremeMauType10GBaseCX4 OBJECT IDENTIFIER
 ::= { extremeMauType 15 }
      "10 Gigabit CX4"
extremeMauType10GBaseZR OBJECT IDENTIFIER
 ::= { extremeMauType 16 }
      "10 Gigabit ZR"
extremeMauType10GBaseDWDM OBJECT IDENTIFIER
 ::= { extremeMauType 17 }
      "10 Gigabit DWDM"

```

```

extremeMauType10GBaseCX OBJECT IDENTIFIER
 ::= { extremeMauType 18 }
      "10 Gigabit CX - SFP+ twin coax cable"
extremeMauType10GBaseT OBJECT IDENTIFIER
 ::= { extremeMauType 19 }
      "10 Gigabit BaseT"
extremeMauType40G OBJECT IDENTIFIER
 ::= { extremeMauType 20 }
      "40 Gigabit interface"

```

Corresponding MAU Type List Bits values have been added:

```

extreme_ifMauTypeListBits_b1000baseWDMHD-- 64
extreme_ifMauTypeListBits_b1000baseWDMFD-- 65
extreme_ifMauTypeListBits_b1000baseLX70HD-- 66
extreme_ifMauTypeListBits_b1000baseLX70FD-- 67
extreme_ifMauTypeListBits_b1000baseZXHD-- 68
extreme_ifMauTypeListBits_b1000baseZXFD-- 69

```

The following standards-based additions have been made as a 'Work in Progress', as per *draft-ietf-hubmib-mau-mib-v3-02.txt*:

1 A new enumeration 'fiberLC(14)' for the JackType textual convention.

2 New MAU types:

```

dot3MauType10GigBaseX OBJECT-IDENTITY
  STATUS      current
  DESCRIPTION "X PCS/PMA (per 802.3 section 48), unknown PMD."
  ::= { dot3MauType 31 }

dot3MauType10GigBaseLX4 OBJECT-IDENTITY
  STATUS      current
  DESCRIPTION "X fiber over WDM optics (per 802.3 section 53)"
  ::= { dot3MauType 32 }

dot3MauType10GigBaseR OBJECT-IDENTITY
  STATUS      current
  DESCRIPTION "R PCS/PMA (per 802.3 section 49), unknown PMD."
  ::= { dot3MauType 33 }

dot3MauType10GigBaseER OBJECT-IDENTITY
  STATUS      current
  DESCRIPTION "R fiber over 1550 nm optics (per 802.3 section 52)"
  ::= { dot3MauType 34 }

dot3MauType10GigBaseLR OBJECT-IDENTITY
  STATUS      current
  DESCRIPTION "R fiber over 1310 nm optics (per 802.3 section 52)"
  ::= { dot3MauType 35 }

dot3MauType10GigBaseSR OBJECT-IDENTITY
  STATUS      current
  DESCRIPTION "R fiber over 850 nm optics (per 802.3 section 52)"
  ::= { dot3MauType 36 }

```

```

dot3MauType10GigBaseW OBJECT-IDENTITY
    STATUS      current
    DESCRIPTION "W PCS/PMA (per 802.3 section 49 and 50), unknown PMD."
    ::= { dot3MauType 37 }

dot3MauType10GigBaseEW OBJECT-IDENTITY
    STATUS      current
    DESCRIPTION "W fiber over 1550 nm optics (per 802.3 section 52)"
    ::= { dot3MauType 38 }

dot3MauType10GigBaseLW OBJECT-IDENTITY
    STATUS      current
    DESCRIPTION "W fiber over 1310 nm optics (per 802.3 section 52)"
    ::= { dot3MauType 39 }

dot3MauType10GigBaseSW OBJECT-IDENTITY
    STATUS      current
    DESCRIPTION "W fiber over 850 nm optics (per 802.3 section 52)"
    ::= { dot3MauType 40 }
    
```

3 Corresponding new Mau Type List bit values:

- b10GbaseX(31) – 10GBASE-X
- b10GbaseLX4(32) – 10GBASE-LX4
- b10GbaseR(33) – 10GBASE-R
- b10GbaseER(34) – 10GBASE-ER
- b10GbaseLR(35) – 10GBASE-LR
- b10GbaseSR(36) – 10GBASE-SR
- b10GbaseW(37) – 10GBASE-W
- b10GbaseEW(38) – 10GBASE-EW
- b10GbaseLW(39) – 10GBASE-LW
- b10GbaseSW(40) – 10GBASE-SW

RFC 2737 (ENTITY-MIB)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
entityPhysicalTable	entPhysicalIndex	
	entPhysicalDescr	
	entPhysicalVendorType	
	entPhysicalContainedIn	
	entPhysicalClass	
	entPhysicalParentRelPos	
	entPhysicalName	
	entPhysicalHardwareRev	
	entPhysicalFirmwareRev	
	entPhysicalSoftwareRev	
	entPhysicalSerialNum	
	entPhysicalMfgName	

Table/Group	Supported Variables	Comments
	entPhysicalModelName	
	entPhysicalAlias	
	entPhysicalAssetID	
	entPhysicalsFRU	

RFC 2787 (VRRP-MIB)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
vrrpOperations	vrrpNodeVersion	
	vrrpNotificationCntl	
vrrpStatistics	vrrpRouterChecksumErrors	
	vrrpRouterVersionErrors	
	vrrpRouterVrldErrors	
vrrpOperTable	All objects	Creation of a new row or modifying an existing row requires vrrpOperAdminState to be set to <i>down</i> ; otherwise any kind of set will fail on this table. vrrpOperAuthType does not support <i>ipAuthenticationHeader</i> .
vrrpAssolpAddrTable	All objects	
vrrpRouterStatsTable	All objects	
vrrpNotifications	vrrpTrapNewMaster	
	vrrpTrapAuthFailure	

RFC 3621 (PoE-MIB)

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
pethPsePortTable	All objects	Objects in this table are read-only.
pethMainPseTable	All objects	Objects in this table are read-only.
pethNotifications	pethPsePortOnOffNotification	
	pethMainPowerUsageOnNotification	
	pethMainPowerUsageOffNotification	

RFC 5601 (PW-STD-MIB)

The following tables, groups, and variables are supported in this MIB. All tables and variables of this MIB are supported as read only. The comments here are abbreviated versions of the description in the RFC documentation.

Table/Group	Supported Variables	Comments
pwTable	pwIndex	A unique index for the conceptual row identifying a PW within this table.
	pwPeerAddr	This object contains the value of the peer node address of the PW/PE maintenance protocol entity. This object should contain a value of all zeroes if not applicable (pwPeerAddrType is 'unknown').
	pwID	Pseudowire identifier. If the pwOwner object is <i>pwIdFecSignaling</i> or <i>I2tpControlProtocol</i> , then this object is signaled in the outgoing PW ID field within the <i>Virtual Circuit FEC Element</i> . For other values of pwOwner, this object is not signaled and it can be set to zero.
	pwLocalCapabAdvert	If a maintenance protocol is used, it indicates the capabilities the local node will advertise to the peer.
	pwRemoteGroupID	This object is obtained from the Group ID field as received through the maintenance protocol used for PW setup. Value of zero is reported if not used. Value of 0xFFFFFFFF is used if the object is yet to be defined by the PW maintenance protocol.
	pwOutboundLabel	The PW label used in the outbound direction (i.e., toward the PSN). It might be set manually if pwOwner is 'manual'; otherwise, it is set automatically.
	pwInboundLabel	The PW label used in the inbound direction (i.e., packets received from the PSN). It may be set manually if pwOwner is 'manual'; otherwise, it is set automatically.
	pwCreateTime	The value of sysUpTime at the time this PW was created.
	pwUpTime	Specifies the time since last change of pwOperStatus to <i>Up</i> (1).
	pwLastChange	The value of sysUpTime at the time the PW entered its current operational state. If the current state was entered prior to the last re-initialization of the local network management subsystem, then this object contains a zero value.
	pwAdminStatus	The desired operational status of this PW. This object can be set at any time.
	pwOperStatus	This object indicates the operational status of the PW; it does not reflect the status of the Customer Edge (CE) bound interface.
	pwLocalStatus	Indicates the status of the PW in the local node.
	pwRemoteStatus	Indicates the status of the PW as was advertised by the remote.

Table/Group	Supported Variables	Comments
	pwRowStatus	For creating, modifying, and deleting this row. This object can be changed at any time.
	pwOamEnable	This variable indicates if OAM is enabled for this PW. It can be changed at any time.
pwIndexMappingTable	All objects	This table enables the reverse mapping of the unique PwId parameters [peer IP, PW type, and PW ID] and the pwIndex. The table is not applicable for PWs created manually or by using the generalized FEC.

RFC 5602 (PW-MPLS-STD-MIB)

The following tables, groups, and variables are supported in this MIB. All tables and variables of this MIB are supported as *read only*. The comments here are abbreviated versions of the description in the RFC documentation.

Table/Group	Supported Variables	Comments
pwMplsTable	pwIndex	This table controls MPLS-specific parameters when the PW is going to be carried over MPLS PSN.
	pwMplsMplsType	This object is set by the operator to indicate the outer tunnel types, if existing.
	pwMplsTtl	This object is set by the operator to indicate the PW TTL value to be used on the PW shim label.
	pwMplsLocalLdpID	The LDP identifier of the LDP entity that creates this PW in the local node.
	pwMplsLocalLdpEntityIndex	The local node LDP Entity Index of the LDP entity creating this PW.
	pwMplsPeerLdpID	The peer LDP identifier of the LDP session. This object should return the value zero if LDP is not used or if the value is not yet known.
pwMplsOutboundTable	All objects	This table reports and configures the current outbound MPLS tunnels (i.e., toward the PSN) or the physical interface in the case of a PW label only that carries the PW traffic. It also reports the current outer tunnel and LSP that forward the PW traffic.

RFC 5603 (PW-ENET-STD-MIB)

The following tables, groups, and variables are supported in this MIB. All tables and variables of this MIB are supported as *read only*. The comments here are abbreviated versions of the description in the RFC documentation.

Table/Group	Supported Variables	Comments
pwEnetTable	pwIndex	This table contains the index to the Ethernet tables associated with this Ethernet PW, the VLAN configuration, and the VLAN mode.
	pwEnetPwInstance	If multiple rows are mapped to the same PW, this index is used to uniquely identify the individual row.
	pwEnetPwVlan	This object defines the (service-delimiting) VLAN field value on the PW.

Table/Group	Supported Variables	Comments
	pwEnetVlanMode	This object indicates the mode of VLAN handling between the port or the virtual port associated with the PW and the PW encapsulation.
	pwEnetPortVlan	This object defines if the mapping between the original port (physical port or VPLS virtual port) to the PW is VLAN based or not.
	pwEnetPortIfIndex	This object is used to specify the ifIndex of the Ethernet port associated with this PW for point-to-point Ethernet service, or the ifIndex of the virtual interface of the VPLS instance associated with the PW if the service is VPLS.
	pwEnetRowStatus	This object enables creating, deleting, and modifying this row.

VPLS-MIB (draft-ietf-l2vpn-vpls-mib-02.txt)

The following tables, groups, and variables are supported in this MIB. All tables and variables of this MIB are supported as read only. The comments here are abbreviated versions of the description in the RFC documentation.

Table/Group	Supported Variables	Comments
vplsConfigTable	vplsConfigIndex	Unique index for the conceptual row identifying a VPLS service.
	vplsConfigName	A textual name of the VPLS. If there is no local name, or this object is otherwise not applicable, then this object MUST contain a zero-length octet string.
	vplsConfigAdminStatus	The desired administrative state of the VPLS service.
	vplsConfigRowStatus	For creating, modifying, and deleting this row.
	vplsConfigMtu	The value of this object specifies the MTU of this vpls instance.
	vplsConfigVpnId	This object indicates the IEEE 802-1990 VPN ID of the associated VPLS service.
vplsStatusTable	All objects	This table provides information for monitoring VPLS.
vplsPwBindTable	vplsConfigIndex	This table provides an association between a VPLS service and the corresponding PWs. A service can have more than one PW association. PWs are defined in the pwTable.
	vplsPwBindIndex	
	vplsPwBindType	The value of this object indicates whether the PW binding is of type <i>mesh</i> or <i>spoke</i> .
	vplsPwBindRowStatus	For creating, modifying, and deleting this row.

Extreme Networks Proprietary MIBs

The Extreme Networks MIBs are located on the eSupport web site under Download Software Updates, located at <https://esupport.extremenetworks.com/>. The following sections describe these MIBs:

- [EXTREME-AUTOPROVISION-MIB on page 1587](#)
- [EXTREME-CLEARFLOW-MIB on page 1588](#)
- [EXTREME-EDP-MIB on page 1588](#)
- [EXTREME-ENTITY-MIB on page 1589](#)
- [EXTREME-ESRP-MIB on page 1589](#)
- [EXTREME-FDB-MIB on page 1589](#)
- [EXTREME-MPLS-MIB on page 1590](#)
- [EXTREME-MPLS-TE-MIB on page 1594](#)
- [EXTREME-OSPF-MIB on page 1595](#)
- [EXTREME-PoE-MIB on page 1595](#)
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- [EXTREME-SNMPv3-MIB on page 1602](#)
- [EXTREME-STPEXTENSIONS-MIB on page 1603](#)
- [EXTREME-STPNOTIFICATIONS-MIB on page 1603](#)
- [EXTREME-SYSTEM-MIB on page 1604](#)
- [EXTREME-TRAP-MIB on page 1612](#)
- [EXTREME-TRAPPOLL-MIB on page 1613](#)
- [EXTREME-V2TRAP-MIB on page 1614](#)
- [EXTREME-VLAN-MIB on page 1614](#)
- [EXTREME-VM-MIB on page 1616](#)

EXTREME-AUTOPROVISION-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremeAutoProvisionConfig		Enables or disables the Auto Provision feature on the switch.

The following traps can be generated.

Trap	Notification Objects	Comments
extremeAutoProvisionStatus		This trap reports the auto provision result (success/failed). It contains the attributes it received from the DHCP server.
	extremeAutoProvisionResult	Result of the Auto provision.
	extremAutoProvisionIpAddress	The IP address received from the DHCP server for this interface.

	extremeAutoProvisionGateway	The gateway address received from the DHCP server for this interface.
	extremeAutoProvisionTFTPServer	The IP address of the TFTP server received from the DHCP server.
	extremeAutoProvisionConfigFileName	The configuration file name received from the DHCP server which the auto-provision enabled switch will download from the TFTP server and apply. It can use either the cfg or xsf extension.

EXTREME-CLEARFLOW-MIB

This MIB defines the following Extreme-specific CLEAR-Flow traps generated by Extreme Networks devices.

Trap	Comments
extremeClearflowMessage	CLEAR-Flow message trap.
The varbinds supported in this trap are:	
extremeClearflowMsgId	User-defined message ID.
extremeClearflowMsg	User-defined message.
extremeClearflowPolicyName	Policy file name.
extremeClearflowRuleName	Rule name which triggered this message.
extremeClearflowRuleValue	Calculated rule value.
extremeClearflowRuleThreshold	Rule threshold value.
extremeClearflowRuleInterval	Rule sampling and evaluation interval.
extremeClearflowVlanName	VLAN name on which this policy is applied.
extremeClearflowPortName	Port name on which this policy is applied.

EXTREME-EDP-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremeEdpTable	All objects	This table contains EDP information of this device.
extremeEdpNeighborTable	All objects	This table contains EDP neighbor information.
extremeEdpPortTable	All objects	

EXTREME-ENTITY-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremeEntityFRUTable	entPhysicalIndex	A table containing information about each FRU in the chassis based on the Entity MIB.
	extremeEntityFRUStartTime	First recorded start time.
	extremeEntityFRUOdometer	Number of time units in service.
	extremeEntityFRUOdometerUnit	Time unit used to represent value reported by extremeEntityFRUOdometer. Depends on the underlying hardware capability.

EXTREME-ESRP-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremeEsrpDomainTable	All objects	This table contains information for ESRP domains on this device.
extremeEsrpDomainMemberTable	All objects	This table contains information for member VLANs of the ESRP domain.
extremeEsrpDomainNeighborTable	All objects	This table contains neighbor router information for ESRP domains on this device.
extremeEsrpDomainAwareTable	All objects	This table contains ESRP aware information for this device.
extremeEsrpDomainStatsTable	All objects	This table contains statistics on ESRP hello packets exchanged and ESRP state changes for this device.
extremeEsrpNotifications	extremeEsrpDomainStateChange	Signifies ESRP state change.

EXTREME-FDB-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremeFdbMacFdbTable	All objects	Not supported
extremeFdbIpFdbTable	All objects	Supports SNMP get and get next operations only.
extremeFdbPermFdbTable	All objects	
extremeFdbMacExosFdbTable	extremeFdbMacExosFdbEntry	A table that contains information about the hardware MAC FDB table. Supported only on switches running ExtremeXOS. Supports SNMP get and get next operations only.
extremeFdbMacFdbCounterTable	All objects	Supports SNMP get and get next operations only.

Trap	Comments
extremeMACTrackingAdd	The specified MAC address was added to the FDB on the mentioned port and VLAN.
extremeMACTrackingDel	The specified MAC address was deleted from the FDB on the mentioned port and VLAN.
extremeMACTrackingMove	The specified MAC address was moved from the previous port to the new port on the specified VLAN.

EXTREME-MPLS-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremeMplsNotifications	extremepwUpDownNotificationEnable	If this object is set to <i>true</i> (1), then it enables the emission of pwUp and pwDown notifications; otherwise these notifications are not emitted.
	extremepwDeletedNotificationEnable	If this object is set to <i>true</i> (1), then it enables the emission of pwDeleted notification; otherwise this notification is not emitted.
	pwNotificationMaxRate	This variable indicates the maximum number of notifications issued per second. If events occur more rapidly, the implementation may simply fail to emit these notifications during that period, or might queue them until an appropriate time. A value of 0 means no throttling is applied and events might be notified at the rate at which they occur.
	extremepwNotificationPwIndex	This variable indicates the index of the PW that either went up, down, or was deleted as reported by the corresponding notification.
	extremepwNotificationPwOperStatus	This variable is used to report the value of pwOperStatus in pwTable (RFC 5601) associated with the PW that went up or down.
	extremepwNotificationPeerAddrType	Denotes the address type of the peer node.
	extremepwNotificationPeerAddr	This object contains the value of the peer node address.
	extremeMplsNotifTunnelIndex	Uniquely identifies a set of tunnel instances between a pair of ingress and egress LSRs. Contains part of the index of a TE tunnel that underwent state change. The same tunnel can also be looked up in the TE MIB.
	extremeMplsNotifTunnelInstance	Uniquely identifies a particular instance of a tunnel between a pair of ingress and egress LSRs.
	extremeMplsNotifTunnelIngressLSRId	Identity of the ingress LSR associated with this tunnel instance.
	extremeMplsNotifTunnelEgressLSRId	Identity of the egress LSR associated with this tunnel instance.
	extremeMplsNotifTunnelAdminStatus	Reports the desired operational status of this tunnel.

	extremeMplsNotifTunnelOperStatus	Reports the actual operational status of this tunnel, which is typically but not limited to, a function of the state of individual segments of this tunnel.
	extremeMplsNotifLdpEntityLdpId	The LDP identifier. This is the primary index to identify a row in the mplsLdpEntityTable (RFC 3815).
	extremeMplsNotifLdpEntityIndex	This index is used as a secondary index to uniquely identify a row in the mplsLdpEntityTable (RFC 3815). This object is meaningful to some, but not all, LDP implementations.
	extremeMplsNotifLdpPeerLdpId	The LDP identifier of this LDP Peer.
	extremeMplsNotifLdpSessionState	The current state of the session, all of the states 1 to 5 are based on the state machine for session negotiation behavior.
	extremeMplsNotifLdpSessionDiscontinuityTime	The initial value of this object is the value of sysUpTime when the entry was created in this table. Subsequent notifications report the time when the session between a given entity and peer goes away or a new session is established.
	extremeVplsNotifConfigIndex	Unique index for the conceptual row identifying a VPLS service in the vplsConfigTable.
	extremeVplsNotifConfigVpnId	This objects indicates the IEEE 802-1990 VPN ID of the associated VPLS service. This object has the same value as vplsConfigVpnId in the vplsConfigTable for an index value equal to extremeVplsNotifConfigIndex sent in the notification.
	extremeVplsNotifConfigAdminStatus	The administrative state of the VPLS service. This object has the same value as vplsConfigAdminStatus in the vplsConfigTable for an index value equal to extremeVplsNotifConfigIndex sent in the notification.
	extremeVplsNotifStatusOperStatus	The current operational state of this VPLS service. A value of <i>up</i> (1) indicates that all PWs for this VPLS are up and the attachment circuit is up. A value of <i>degraded</i> (2) indicates that at least one PW for this VPLS is up and the attachment circuit is up. A value of <i>down</i> (3) indicates that all PWs for this VPLS are down or the attachment circuit is down.
	extremePwStatusChange	This notification is generated when the pwOperStatus object for a pseudowire transitions from <i>up</i> (1) to <i>down</i> (2) or from <i>down</i> (2) to <i>up</i> (1).
	extremePwDeleted	This notification is generated when a PW has been deleted.

	extremeMplsTunnelStatusChange	This notification is generated when the mplsTunnelOperStatus object for a TE-LSP transitions from <i>up</i> (1) to <i>down</i> (2) or from <i>down</i> (2) to <i>up</i> (1). This new state is indicated by the included value of mplsTunnelOperStatus.
	extremeMplsLdpSessionStatusChange	This notification is generated when the value of 'mplsLdpSessionState' (RFC3815) enters or leaves the <i>operational</i> (5) state.
	extremeVplsStatusChange	This notification is generated to inform recipients of the state of the VPLS. When all PWs in this VPLS are up or ready and the attachment circuit is up, extremeVplsNotifStatusOperStatus is set to <i>vplsOperStatusUp</i> (1) in the notification. When at least one PW in this VPLS is up or ready and the attachment circuit is up, extremeVplsNotifStatusOperStatus is set to <i>vplsOperStatusDegraded</i> (2) in the notification. When all PWs in this VPLS are down or the attachment circuit is down, extremeVplsNotifStatusOperStatus is set to <i>vplsOperStatusDown</i> (3) in the notification. Once a notification has been sent with <i>vplsOperStatusDegraded</i> (2), no further notification will be sent until extremeVplsNotifStatusOperStatus transitions to <i>vplsOperStatusUp</i> (1) or <i>vplsOperStatusDown</i> (3).
extremeVplsConfigTable		This table specifies information for configuring and monitoring VPLS.
	extremeVplsConfigEntry	A row in this table represents a VPLS in a packet network. It is indexed by extremeVplsConfigIndex, which uniquely identifies a single VPLS.
ExtremeVplsConfigEntry	extremeVplsConfigIndex	Unique index for the conceptual row identifying a VPLS service.
	extremeVplsConfigRedunType	This variable indicates the redundancy type for this VPLS. Redundancy states can be <i>None</i> , <i>EAPS</i> , <i>ESRP</i> and <i>STP</i> .
	extremeVplsConfigEAPSStatus	This variable indicates the EAPS redundancy status for this VPLS. It displays <i>Protected</i> if the VLAN is protected, else <i>Not Protected</i> . EAPS status displays the following values: <ul style="list-style-type: none"> • <i>Waiting</i>—if waiting on EAPS status. • <i>Connected</i>—if EAPS ring status is <i>connected to VLAN</i>. PW is not installed in this state. • <i>Disconnected</i>—if EAPS ring state is <i>disconnected</i>. PW is installed in this state. • <i>Unknown</i>—if EAPS is not found.
	extremeVplsConfigESRPState	This variable indicates the ESRP redundancy state for this VPLS. ESRP states can have two values: <i>master</i> and <i>slave</i> . PW is installed only when ESRP is in the master state.

extremeVplsStatusTable		This table specifies information for configuring and monitoring VPLS.
	extremeVplsStatusEntry	A row in this table represents a VPLS in a packet network. It is indexed by extremeVplsConfigIndex, which uniquely identifies a single VPLS.
	extremeVplsStatusIndex	Unique index for the conceptual row identifying a VPLS service.
	extremeVplsOperStatus	This variable indicates the VPLS operation status. This is different from the VPLS PW status shown in the standard MIB. Supported values are: <ul style="list-style-type: none"> Up—all PWs are in the Up or Ready state. Degraded—At least one PW is in the Up or Ready state. Down—None of the PWs are in Up or Ready state.
extremeVplsPeerTable		This table provides information for monitoring VPLS peer entries.
	extremeVplsPeerEntry	This entry contains information for all the peers belonging to a particular VPLS.
	extremeVplsIndex	Unique index for the conceptual row identifying a VPLS service.
	extremeVplsPwBindIndex	Secondary Index for the conceptual row identifying a PW within the PwEntry which must match an entry from the PW-STD-MIB's PwTable, which represents an already-provisioned PW that is then associated with this VPLS instance.
	extremePwInstalled	Boolean true or false, indicating if PW is installed.
	extremePwMode	The peer mode of this PW. It indicates its current mode and the mode of the switch it is connected to. It can have the following values: <i>Core-to-core</i> , <i>Core-to-Spoke</i> , and <i>Spoke-to-Core</i> .
	extremePwConfiguredRole	The configured role of this PW. It applies only in the case the PwMode is <i>Core-to-core</i> . In this case, the configured role can either be <i>Primary</i> or <i>Secondary</i> . For all the other PW modes, the configured role does not apply.

The following traps can be generated.

Trap	Comments
pwStatusChange	This notification is generated when the pwOperStatus object for a PW transitions from <i>up</i> (1) to <i>down</i> (2) or from <i>down</i> (2) to <i>up</i> (1).
pwDeleted	This notification is generated when a PW has been deleted.
extremeMPLSTrapsEnable	MPLS trap status. If enabled then all the MPLS related traps are sent out.
extremeL2VpnTrapsEnable	L2VPN trap status. If enabled then all the L2VPN related traps are sent out.

EXTREME-MPLS-TE-MIB

The following tables, groups, and variables are supported in this MIB

Table/Group	Supported Variables	Comments
extremeMplsTunnelTable	mplsTunnelIndex	The mplsTunnelTable (see RFC3812) allows new MPLS tunnels to be created between an LSR and a remote endpoint, and existing tunnels to be reconfigured or removed. Note that only point-to-point tunnel segments are supported, although multipoint-to-point and point-to-multipoint connections are supported by an LSR acting as a cross-connect. Each MPLS tunnel can thus have one out-segment originating at this LSR and/or one in-segment terminating at this LSR. Extreme Networks MPLS implementation allows tunnel instances with a common endpoint to be grouped at the ingress LSR to provide redundancy. The role of each tunnel in the group must be configured and is indicated by extremeMplsTunnelRedundancyType.
	mplsTunnelInstance	Uniquely identifies a particular instance of a tunnel between a pair of ingress and egress LSRs. It is useful to identify multiple instances of tunnels for the purposes of backup and parallel tunnels.
	mplsTunnelIngressLSRId	Identity of the ingress LSR associated with this tunnel instance.
	mplsTunnelEgressLSRId	Identity of the egress LSR associated with this tunnel instance.
	mplsTunnelRedundancyType	Identifies the tunnel redundancy type associated with this tunnel instance. A value of <i>primary</i> (1) or <i>secondary</i> (2) MAY be assigned by the network administrator or by an SNMP manager at the time of setting up the tunnel.
	mplsTunnelRedundancyStatus	Indicates the actual redundancy status of this tunnel. When the status is active, the tunnel is the preferred tunnel in the group.
	mplsTunnelTransportStatus	Indicates the type of traffic the tunnel group can be used for sending. <ul style="list-style-type: none"> When the status is <i>allowAllIp</i> (0), IP traffic destined for all IPv4 routes is allowed over any tunnel in the group marked active. When the status is <i>allowAssignedIpOnly</i> (1), IP traffic destined only for IPv4 static routes that have been explicitly configured to use this tunnel group is allowed. When the status is <i>allowAllLayer2Vpn</i> (2), Layer 2 VPN traffic for all Layer 2 VPNs is allowed over any tunnel in the group marked active. When the status is <i>allowAssignedLayer2VpnOnly</i> (3), Layer 2 VPN traffic destined only for PWs that have been explicitly configured to use this tunnel group are allowed.

EXTREME-OSPF-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremeOspfInterfaceTable	All objects	This table contains Extreme Networks specific information about OSPF interfaces.

EXTREME-PoE-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremePethSystemAdminEnable		Objects are supported read-only.
extremePethSystemDisconnect Precedence		
extremePethSystemUsageThreshold		
extremePethSystemPowerSupplyMode		
extremePethPseSlotTable	All objects	
extremePethPsePortTable	All objects	

EXTREME-PORT-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremePortLoadshareTable	All objects	Not supported
extremePortSummitlinkTable	All objects	Not supported.
extremePortLoadshare2Table	extremePortLoadshare2Entry	A table of bindings between a master port and its load-sharing slaves. Create/delete entries here to add/delete a port to/from a load-sharing group. Default is empty table. There are restrictions on what row creates will be accepted by each device.
	extremePortLoadshare2MasterIf Index	The ifIndex value which identifies the port controlling a load-sharing group of ports that includes extremePortLoadshareSlaveIfIndex.
	extremePortLoadshare2SlaveIfIndex	The ifIndex value which identifies the port which is a member of a load-sharing group controlled by extremePortLoadshare2MasterIfIndex.
	extremePortLoadshare2Algorithm	This value identifies the load sharing algorithm to be used for this group of load shared ports.

Table/Group	Supported Variables	Comments
	extremePortLoadshare2Status	The row status variable, used according to row installation and removal conventions.
extremePortRateShapeTable	All objects	Not supported
extremePortUtilizationTable	extremePortUtilizationEntry	Global QoS profiles are defined in the extremeQosProfileTable. This table contains a list of ports for which certain QoS parms are reported.
	extremePortUtilizationAvgTxBw	The reported average bandwidth in the transmit direction. When displayed, it shows as an integer value. For example, 99.99% is displayed as 9999.
	extremePortUtilizationAvgRxBw	The reported average bandwidth in the receive direction. When displayed, it shows as an integer value. For example, 99.99% is displayed as 9999.
	extremePortUtilizationPeakTxBw	The reported peak bandwidth in the transmit direction. When displayed it shows as an integer value. For example, 99.99% is displayed as 9999.
	extremePortUtilizationPeakRxBw	The reported peak bandwidth in the receive direction. When displayed it shows as an integer value. For example, 99.99% is displayed as 9999.
extremePortInfoTable	All objects	Not supported
extremePortXenpakVendorTable	All objects	Not supported
extremePortIngressStatsPortTable	All objects	Not supported
extremePortIngressStatsQueue Table	All objects	Not supported
extremePortEgressRateLimitTable	All objects	Not supported
extremeWiredClientTable	All objects	Not supported
extremePortUtilizationExtnTable	extremePortUtilizationExtnEntry	Global QoS profiles are defined in the extremeQosProfileTable. This table contains a list of ports for which certain QoS parameters are reported.
	extremePortUtilizationAvgTxPkts	The reported number of average packets in the transmit direction per second.
	extremePortUtilizationAvgRxBw	The reported number of average packets in the receive direction per second.
	extremePortUtilizationPeakTxPkts	The reported number of peak packets in the transmit direction per second.

Table/Group	Supported Variables	Comments
	extremePortUtilizationPeakRxPkts	The reported number of peak packets in the receive direction per second.
	extremePortUtilizationAvgTxBytes	The reported number of average bytes in the transmit direction per second.
	extremePortUtilizationAvgRxBytes	The reported number of average bytes in the receive direction per second.
	extremePortUtilizationPeakTxBytes	The reported number of peak bytes in the transmit direction per second.
	extremePortUtilizationPeakRxBytes	The reported number of peak bytes in the receive direction per second.
extremePortQosStatsTable	extremePortQosStatsEntry	This table lists Ports QoS information for either ingress or egress.
	extremePortQosIngress	Indicates whether the port is in ingress/egress.
	extremePortQP0TxBytes	The number of QoS 0 bytes that gets transmitted from this port.
	extremePortQP0TxPkts	The number of QoS 0 packets that gets transmitted from this port.
	extremePortQP1TxBytes	The number of QoS 1 bytes that gets transmitted from this port.
	extremePortQP1TxPkts	The number of QoS 1 packets that gets transmitted from this port.
	extremePortQP2TxBytes	The number of QoS 2 bytes that gets transmitted from this port.
	extremePortQP2TxPkts	The number of QoS 2 packets that gets transmitted from this port.
	extremePortQP3TxBytes	The number of QoS 3 bytes that gets transmitted from this port.
	extremePortQP3TxPkts	The number of QoS 3 packets that gets transmitted from this port.
	extremePortQP4TxBytes	The number of QoS 4 bytes that gets transmitted from this port.
	extremePortQP4TxPkts	The number of QoS 4 packets that gets transmitted from this port.
	extremePortQP5TxBytes	The number of QoS 5 bytes that gets transmitted from this port.
	extremePortQP5TxPkts	The number of QoS 5 packets that gets transmitted from this port.
	extremePortQP6TxBytes	The number of QoS 6 bytes that gets transmitted from this port.
	extremePortQP6TxPkts	The number of QoS 6 packets that gets transmitted from this port.
	extremePortQP7TxBytes	The number of QoS 7 bytes that gets transmitted from this port.
	extremePortQP7TxPkts	The number of QoS 7 packets that gets transmitted from this port.

Table/Group	Supported Variables	Comments
extremePortMauTable	extremePortMauEntry	Port Optics Status Table.
	extremePortMauType	This object identifies the MAU type.
	extremePortMauVendorName	This object identifies the MAU vendor name.
	extremePortMauStatus	This object identifies the status of the MAU for this interface.
extremePortCongestionStatsTable	extremePortCongestionStatsEntry	This table lists ports congestion information.
	extremePortCongDropPkts	The number of packets dropped due to congestion on this port.
extremePortQosCongestionStatsTable	extremePortQosCongestionStatsEntry	This table lists ports per QoS congestion information.
	extremePortQP0CongPkts	The number of QoS 0 packets that got dropped due to congestion on this port.
	extremePortQP1CongPkts	The number of QoS 1 packets that got dropped due to congestion on this port.
	extremePortQP2CongPkts	The number of QoS 2 packets that got dropped due to congestion on this port.
	extremePortQP3CongPkts	The number of QoS 3 packets that got dropped due to congestion on this port.
	extremePortQP4CongPkts	The number of QoS 4 packets that got dropped due to congestion on this port.
	extremePortQP5CongPkts	The number of QoS 5 packets that got dropped due to congestion on this port.
	extremePortQP6CongPkts	The number of QoS 6 packets that got dropped due to congestion on this port.
	extremePortQP7CongPkts	The number of QoS 7 packets that got dropped due to congestion on this port.

The following traps can be generated.

Trap	Comments
extremePortMauChangeTrap	This trap is sent whenever a MAU is inserted or removed. When the MAU is inserted, the value of extremePortMauStatus is 'inserted' and extremePortMauType indicates the type of the MAU inserted. If MAU is removed, the value of extremePortMauStatus is empty and the type of the MAU will be <i>NONE</i> .
extremeRateLimitExceededAlarm	This notification indicates the first time a poll of a rate-limited port has a non-zero counter.

EXTREME-QOS-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremeQosProfileTable	extremeQosProfileIndex	An index that uniquely identifies an entry in the QoS table.
	extremeQosProfileName	A unique QoS profile name.
	extremeQosProfileMinBw	The minimum percentage of bandwidth that this queue requires. The switch is required to provide the minimum amount of bandwidth to the queue. The lowest possible value is 0%.
	extremeQosProfileMaxBw	The maximum percentage of bandwidth that this queue is permitted to use.
	extremeQosProfilePriority	The level of priority at which this queue will be serviced by the switch.
	extremeQosProfileRowStatus	The status of the extremeQosProfile entry. This object can be set to: <ul style="list-style-type: none"> • active (1) • createAndGo (4) • createAndWait (5) • destroy (6) The following values may be read: <ul style="list-style-type: none"> • active (1) • notInService (2) • notReady (3)
extremeIqosProfileTable	extremeIqosProfileIndex	The ExtremeXOS software does not support global QoS profile settings in CLI; it supports per port settings only. Walks of this table display the default values with which the ports are initialized.
	extremeIqosProfileName	A unique ingress QoS profile name.
	extremeIqosProfileMinBwType	The type of the current minimum bandwidth setting. A value of 1 signifies that the minimum bandwidth value is a percentage of the configurable port bandwidth. A value of 2 or 3 signifies a guaranteed minimum available bandwidth in Kbps or Mbps, respectively.
	extremeIqosProfileMinBw	The guaranteed minimum bandwidth for this queue, expressed as either a percentage or a specific bandwidth value, as specified by the value of extremeIqosProfileMinBwType.

	extremeIqosProfileMaxBwType	The type of the current maximum bandwidth setting. A value of 1 signifies that the maximum bandwidth value is a percentage of the configurable port bandwidth. A value of 2 or 3 signifies a maximum allowed bandwidth in Kbps or Mbps, respectively.
	extremeIqosProfileMaxBw	The maximum allowed input bandwidth for this queue, expressed as either a percentage or a specific bandwidth value, as specified by the value of extremeIqosProfileMaxBwType.
	extremeIqosProfileRED	The random early drop threshold. When the input queue fill ratio exceeds this percentage, frames start to drop randomly with a linear increasing drop probability as the queue fill count approaches the maximum queue size. A value of 100 indicates that this feature is currently disabled.
	extremeIqosProfileMaxBuf	The percentage of the total ingress queue size to use. Lower values can be used to reduce the maximum latency through this queue, but with potentially greater loss with bursty traffic.
extremePerPortQosTable	extremePerPortQosIndex	The value of this variable is the same as the value of extremeQosProfileIndex of the QoS profile which is overridden (for the port specified by ifIndex) by the definition in this table.
	extremePerPortQosMinBw	The minimum percentage of bandwidth that this queue on the specified port requires. The switch is required to provide the minimum amount of bandwidth to the queue. The lowest possible value is 0%.
	extremePerPortQosMaxBw	The maximum percentage of bandwidth that this queue on the specified port is permitted to use.
	extremePerPortQosPriority	The level of priority at which this queue will be serviced by the switch.
	extremePerPortQosRowStatus	The status of the extremePerPortQos entry. This object can be set to <i>active</i> (1) and <i>createAndGo</i> (4). The following value may be read: <i>active</i> (1). Note that a <i>destroy</i> (6) is not supported. A row will only be deleted from this table when the QoS profile indicated in that row is changed globally.

extremeQosByVlanMapping Table	extremeVlanIfIndex	Shows mapping of VLAN to queues for untagged packets. For tagged packets, the vpri field determines which queue the packet should be using.
	extremeQosByVlanMappingQosProfile Index	Value of extremeQosProfileIndex that uniquely identifies a QoS profile entry in an extremeQosProfileTable. This indicates the QoS to be given to traffic for this VLAN in the absence of any other more specific configuration information for this traffic.

EXTREME-RMON-MIB

The following tables, groups, and variables are supported in this MIB

Table/Group	Supported Variables	Comments
extremeRtStatsTable	extremeRtStatsIndex	All objects are supported as read-only.
	extremeRtStatsIntervalStart	
	extremeRtStatsCRCAlignErrors	
	extremeRtStatsUndersizePkts	
	extremeRtStatsOversizePkts	
	extremeRtStatsFragments	
	extremeRtStatsJabbers	
extremeRtStatsCollisions	extremeRtStatsCollisions	All objects are supported as read-only.
	extremeRtStatsTotalErrors	
	extremeRtStatsUtilization	

EXTREME-SNMPv3-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremeTargetAddrExtTable	extremeTargetAddrExtIgnoreMPModel	When this object is set to TRUE, the version of the trap/notification sent to the corresponding management target (trap receiver) will be the same as in releases of ExtremeWare prior to 7.1.0. Thus, the value of the snmpTargetParamsMPModel object in the snmpTargetParamsTable is ignored while determining the version of the trap/notification to be sent. When a trap-receiver is created through the RMON trapDestTable or from the CLI command 'configure snmp add trapreceiver', the value of this object is set to TRUE for the corresponding entry in this table.
	extremeTargetAddrExtStandardMode	When this object is set to TRUE, the management target is treated as a 'standard mode' one, in that any Extreme Networks specific extra varbinds present in a standards-based trap/notification is not sent to this management target. Only the varbinds defined in the standard are sent.
	extremeTargetAddrExtTrapDestIndex	This object contains the value of the trapDestIndex in the corresponding entry of the RMON trapDestTable.
	extremeTargetAddrExtUseEventComm	This object is used only when sending RMON alarms as SNMPv3 traps. When it is set to TRUE and an RMON risingAlarm or fallingAlarm is being sent for an event, then the eventCommunity in the RMON event table is compared to the snmpTargetAddrName in the snmpTargetAddrTable. The alarm is sent to the target only when the two are the same. This behavior is exhibited only when the snmpTargetParamsMPModel corresponding to the target indicates an SNMPv3 trap. For SNMPv1/v2c traps, the community in the RMON trapDestTable is used for the comparison, which is the <i>regular</i> method, as per the standards. When this object is set to FALSE, then the RMON alarm (if being sent as an SNMPv3 trap) is sent without using the event community for any comparison.
	extremeTargetAddrExtTrapSrcIp	This object contains the source IP address from which traps have to be sent out. If this object is assigned an IP address that does not belong to the switch, an error is thrown.

Table/Group	Supported Variables	Comments
	extremeTargetAddrExtVrName	This object contains the VR name through which the SNMP Traps are being sent out.
extremeUsm3DESPrivProtocol		Supported from ExtremeXOS 12.3
extremeUsmAesCfb192Protocol		Supported from ExtremeXOS 12.3
extremeUsmAesCfb256Protocol		Supported from ExtremeXOS 12.3

EXTREME-STPEXTENSIONS-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremeStpDomainTable	All objects	This table contains STP information per STP domain.
	extremeStpDomainStpdDescription	The description associated with this STP domain.
extremeStpPortTable	All objects	This table contains port-specific information per STP domain.
extremeStpVlanPortTable	All objects	This table contains information of the ports belonging to a STP domain on a per VLAN basis.

EXTREME-STPNOTIFICATIONS-MIB

This MIB defines the following Extreme-specific STP Notifications trap generated by Extreme Networks devices.

Trap	Comments
extremeStpEdgePortLoopDetected	A loop has been detected on the network login edge safeguard port and the port will be disabled.

EXTREME-SYSTEM-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
	extremeSaveConfiguration	When this object is set, the device copies the contents of the configuration database to a buffer and saves it to the persistent store specified by the value of the object. The save is performed asynchronously, and the SNMP agent continues to respond to both gets and sets while the save is taking place. A network management application may use the extremeSaveStatus object to determine when the asynchronous save operation has completed.
	extremeSaveStatus	This object returns the status of a save operation invoked by setting the extremeSaveConfiguration object. A network management application can read this object to determine that a save operation has completed.
	extremeCurrentConfigInUse	Shows which NVRAM configuration store was used at last boot.
	extremeConfigToUseOnReboot	Controls which NVRAM configuration store will be used on next reboot.
	extremeOverTemperatureAlarm	Alarm status of overtemperature sensor in device enclosure.
	extremePrimaryPowerOperational	Not supported. Always returns <i>True</i> .
	extremePowerStatus	Not supported. Always returns <i>presentOK</i> .
	extremePowerAlarm	Not supported. Always returns <i>False</i> .
	extremeRedundantPowerStatus	Not supported. Always returns <i>presentOK</i> .
	extremeRedundantPowerAlarm	Not supported. Always returns <i>presentOK</i> .
	extremeInputPowerVoltage	Contains the input voltage of the latest power-supply to power-on in a system with multiple power-supplies.
	extremePrimarySoftwareRev	This value indicates the revision number of the software image on the primary partition.

Table/Group	Supported Variables	Comments
	extremeSecondarySoftwareRev	This value indicates the revision number of the software image on the secondary partition.
	ExtremeImageToUseOnReboot	This value indicates the partition where the software image is located and to be used on the next boot.
	extremeSystemID	This represents the system ID of a Summit switch.
	extremeSystemBoardID	Not supported.
	extremeSystemLeftBoardID	
	extremeSystemRightBoardID	
	extremeRmonEnable	
	extremeBootROMVersion	Returns information for the current MSM only.
	extremeDot1dTpFdbTableEnable	Not supported.
	extremeHealthCheckErrorType	
	extremeHealthCheckAction	
	extremeHealthCheckMaxRetries	
	extremeCpuUtilRisingThreshold	
	extremeCpuTaskUtilPair	
	extremeCpuAggregateUtilization	
	extremeCpuUtilRisingThreshold	
	extremeAuthFailSrcAddr	
	extremeCpuTransmitPriority	
	extremeImageBooted	
	extremeMasterMSMSlot	This returns the internal slot number assigned to the MSM. Values supported are: <ul style="list-style-type: none"> • 9,10 on the BlackDiamond 10808 • 11,12 on the BlackDiamond 8810 • 7,8 on the BlackDiamond 8806
	extremeChassisPortsPerSlot	Returns the maximum ports per slot for the system.

Table/Group	Supported Variables	Comments
	ExtremeMsmFailoverCause	<p>The cause of the last MSM failover:</p> <ul style="list-style-type: none"> • never (1) means an MSM Failover has not occurred since the last reboot. • admin (2) means the failover was initiated by the user. • exception (3) means the former master MSM encountered a software exception condition. • removal (4) means the master MSM was physically removed from the chassis. • hwFailure (5) means a diagnostic failure was detected in the master MSM. • watchdog (6) means that the master MSM hardware watchdog timer expired. • keepalive (7) means the master MSM failed to respond to slave keepalive requests. The MSM failover will have been hitless only in the <i>admin</i> (2) and <i>exception</i> (3) cases.
extremeFanStatusTable	extremeFanStatusEntry	Operational status of all internal cooling fans.
	extremeFanNumber	Identifier of cooling fan, numbered from the front and/or left side of device.
	extremeFanOperational	Operational status of a cooling fan.
	extremeFanEntPhysicalIndex	The entity index for this fan entity in the entityPhysicalTable table of the entity MIB.
	extremeFanSpeed	The speed (RPM) of a cooling fan in the fantray.
extremeCpuTaskTable	All objects	Not supported.
extremeCpuTask2Table	All objects	Not supported.
extremeSlotTable	All objects	Cards are currently not configurable via SNMP.
extremePowerSupplyTable	extremePowerSupplyStatus	Status of the power supply.
	extremePowerSupplyInputVoltage	Input voltage of the power supply.
	extremePowerSupplyFan1Speed	The speed of Fan-1 in the power supply unit.

Table/Group	Supported Variables	Comments
	extremePowerSupplyFan2Speed	The speed of Fan-2 in the power supply unit.
	extremePowerSupplyInputPowerUsage	Input power usage for the given psu slot. The value 0 in this field indicates the power usage is not supported or that there is a read failure.
	extremePowerMonSupplyNumOutput	Number of output sensors in the power supply unit.
	extremePowerSupplyInputPowerUsageUnitMultiplier	The magnitude of watts for the usage value in extremePowerSupplyInputPowerUsage.
extremePowerSupplyOutputPowerTable	extremePowerSupplyIndex	Power supply unit slot index.
	extremePowerSupplyOutputSensorIdx	Power supply Sensor index.
	extremePowerSupplyOutputVoltage	Output voltage per sensor for the current PSU slot number. A zero (0) in this field indicates that the PSU does not support output voltage reading or else there is an output voltage read error.
	extremePowerSupplyOutputCurrent	Output current per sensor for the current PSU slot number. A zero (0) in this field indicates that the PSU does not support output current reading or else there is an output current read error.
	extremePowerSupplyOutputUnitMultiplier	The magnitude of volts and amps for the usage value in extremePowerSupplyOutputVoltage and extremePowerSupplyOutputCurrent.
extremePowerSupplyUsageTable	extremeSlotIndex	Slot number in the chassis/stack based system.
	extremePowerSupplyUsageValue	Power usage of the particular slot in the chassis or stack. The power usage is measured in milliwatts.
	extremePowerSupplyUnitMultiplier	The magnitude of watts for the usage value in extremePowerSupplyUsageValue.
extremeSystemPowerUsage	extremeSystemPowerUsageValue	The current power usage of the system. In stack mode, this variable tells the total power usage of the entire system.

Table/Group	Supported Variables	Comments
	extremeSystemPowerUsageUnitMultiplier	The magnitude of watts for the usage value in extremeSystemPowerUsageValue.
extremeSystemPowerMonitorTable	extremeSystemPowerMonitorIndex1	Reserved. Can be used for future expansion. Currently set to zero.
	extremeSystemPowerMonitorPollInterval	Configure how often input power is measured. It is configured in seconds with a default value of 60 seconds. If zero (0) is configured, then the input power measurement is disabled.
	extremeSystemPowerMonitorReportChanges	Configure report-changes. Has none or log or trap or log-and-trap, with a default of none.
	extremeSystemPowerMonitorChangeThreshold	Configure the input power change threshold to initiate report-changes action. By default 2 watts is configured. This field is configured in watts.
extremeSystemPowerUsageNotification	sysUpTime, sysDescr, extremeSystemPowerUsageValue, extremeSystemPowerUsageUnitMultiplier	Whenever the power usage is increased/decreased by the configured threshold value, then the power usage trap is generated if the trap is enabled.
extremeImageTable	extremeImageNumber	This table contains image information for all images installed on the device. extremeImageNumber values are not compatible with EW releases. Current image has value 3 instead of 0.
	extremeMajorVersion	This is the first number within the software image version number which consists of 4 numbers separated by a period.
	extremeSubMajorVersion	This is the second number within the software image version number.
	extremeMinorVersion	This is the third number within the software image version number.
	extremeBuildNumber	This is the fourth number within the software image version number.
	extremeTechnologyReleaseNumber	The technology release version. This value is zero for all but TR releases.

Table/Group	Supported Variables	Comments
	extremeSustainingReleaseNumber	The sustaining release number for the ExtremeXOS version.
	extremeBranchRevisionNumber	This is the branch from where the software image was built.
	extremeImageType	This is the software image type (for example, ExtremeXOS core, ExtremeXOS module, ExtremeXOS firmware).
	extremeImageDescription	Description of image contains image version, including major version, submajor version, minor version, build version, build branch, build-master login, and build date.
	extremePatchVersion	The ExtremeXOS release patch version.
extremeImageTable	extremeImageFeatureEntry	A table containing information about the software features.
	extremeImageFeatureNumber	A unique integer identifying the particular software image. This indicates the partition on which the image is loaded: <ul style="list-style-type: none"> • 0—Current partition • 1—Primary partition • 2—Secondary partition
	extremeImageSshCapability	Indicates whether image has SSH capability: <ul style="list-style-type: none"> • 1=noSSH—shown by default when the SSH license is not enabled. • 2=ssh—shown when the SSH license is enabled.
	extremeImageUACapability	Not supported.
extremeCpuMonitorInterval		This value determines how frequent CPU usage will be monitored.
extremeCpuMonitorTotalUtilization		This value indicates the total CPU utilization.
extremeCpuMonitorTable		This value indicates the total CPU utilization.
	extremeCpuMonitorSlotId	This value indicates the slot ID where the CPU is being monitored.
	extremeCpuMonitorProcessName	This value indicates the process name for the process being monitored.
	extremeCpuMonitorProcessId	This value indicates the process ID.

Table/Group	Supported Variables	Comments
	extremeCpuMonitorProcessState	This value indicates the current state of the process.
	extremeCpuMonitorUtilization5secs	This value indicates the CPU utilization in the past 5 seconds.
	extremeCpuMonitorUtilization10secs	This value indicates the CPU utilization in the past 10 seconds.
	extremeCpuMonitorUtilization30secs	This value indicates the CPU utilization in the past 30 seconds.
	extremeCpuMonitorUtilization1min	This value indicates the CPU utilization in the past 1 minute.
	extremeCpuMonitorUtilization5mins	This value indicates the CPU utilization in the past 5 minutes.
	extremeCpuMonitorUtilization30mins	This value indicates the CPU utilization in the past 30 minutes.
	extremeCpuMonitorUtilization1hour	This value indicates the CPU utilization in the past 1 hour.
	extremeCpuMonitorUserTime	This value indicates the CPU usage under User Mode.
	extremeCpuMonitorSystemTime	This value indicates the CPU usage under system mode.
extremeCpuMonitorSystemTable		This table contains CPU monitoring information for all system processes.
	extremeCpuMonitorSystemSlotId	This value indicates the slot ID where the CPU is being monitored.
	extremeCpuMonitorSystemUtilization5secs	This value indicates the CPU utilization in the past 5 seconds.
	extremeCpuMonitorSystemUtilization10secs	This value indicates the CPU utilization in the past 10 seconds.
	extremeCpuMonitorSystemUtilization30secs	This value indicates the CPU utilization in the past 30 seconds.
	extremeCpuMonitorSystemUtilization1min	This value indicates the CPU utilization in the past 1 minute.
	extremeCpuMonitorSystemUtilization5mins	This value indicates the CPU utilization in the past 5 minutes.
	extremeCpuMonitorSystemUtilization30mins	This value indicates the CPU utilization in the past 30 minutes.
	extremeCpuMonitorSystemUtilization1hour	This value indicates the CPU utilization in the past 1 hour.

Table/Group	Supported Variables	Comments
	extremeCpuMonitorSystemMaxUtilization	This value indicates the maximum CPU utilization so far.
extremeMemoryMonitorSystem Table		This table contains system-level memory monitor information.
	extremeMemoryMonitorSystemSlotId	This value indicates the slot ID where the memory is being monitored.
	extremeMemoryMonitorSystemTotal	This value indicates the total memory installed on the switch.
	extremeMemoryMonitorSystemFree	This value indicates the amount of memory that is free.
	extremeMemoryMonitorSystemUsage	This value indicates the amount of memory consumed for kernel code.
	extremeMemoryMonitorUserUsage	This value indicates the amount of memory consumed by user processes as well as the kernel.
extremeMemoryMonitorTable		This table contains memory monitor information for each user process.
	extremeMemoryMonitorSlotId	This value indicates the slot ID where the memory is being monitored.
	extremeMemoryMonitorProcessName	This value indicates the name of the process being monitored.
	extremeMemoryMonitorUsage	This value indicates the amount of memory being consumed by this user process.
	extremeMemoryMonitorLimit	Not supported
	extremeMemoryMonitorZone	
	extremeMemoryMonitorGreenZoneCount	
	extremeMemoryMonitorYellowZoneCount	
	extremeMemoryMonitorOrangeZoneCount	
	extremeMemoryMonitorRedZoneCount	
	extremeMemoryMonitorGreenZone Threshold	
	extremeMemoryMonitorYellowZone Threshold	
	extremeMemoryMonitorOrangeZone Threshold	
	extremeMemoryMonitorRedZoneThreshold	

EXTREME-TRAP-MIB

This MIB defines the following Extreme-specific SNMPv1 traps generated by Extreme Networks devices.

Trap	Comments
extremeOverheat	The on-board temperature sensor has reported an overheat condition. The system shuts down until the unit has sufficiently cooled such that operation can begin again. A cold start trap is issued when the unit has come back on line.
extremeFanFailed	One or more of the cooling fans inside the device has failed. A <i>fanOK</i> trap will be sent once the fan has attained normal operation.
extremeFanOK	A fan has transitioned out of a failure state and is now operating correctly.
extremeInvalidLoginAttempt	A user attempted to log into the console or by telnet but was refused access due to an incorrect username or password.
extremePowerSupplyGood	One or more previously bad sources of power to this agent has come back to life without causing an agent restart.
extremePowerSupplyFail	One or more sources of power to this agent has failed. Presumably a redundant power-supply has taken over.
extremeEdpNeighborAdded	This node discovers a new neighbor through Extreme Discovery Protocol (EDP).
extremeEdpNeighborRemoved	No EDP updates are received from this neighbor within the configured timeout period and this neighbor entry is aged out by the device.
extremeModuleStateChanged	Signifies that the value of the <i>extremeSlotModuleState</i> for the specified <i>extremeSlotNumber</i> has changed. Traps are reported only for significant states.

EXTREME-TRAPPOLL-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
	extremeSmartTrapFlushInstanceTableIndex	This object acts as a flush control for the extremeSmartTrapInstanceTable. Setting this object can flush the matching entries from the extremeSmartTrapInstanceTable based on certain rules as defined in the MIB.
extremeSmartTrapRulesTable		<p>The entries created in the extremeSmartTrapRulesTable define the rules that are used to generate Extreme smart traps.</p> <p>The object extremeSmartTrapRulesDesiredOID supports OID values whose prefix are among the following:</p> <ul style="list-style-type: none"> • ipAddrTable • ifMauTable • extremeSlotTable • extremeVlanGroup • extremeVirtualGroup • extremeVlanProtocolTable • extremeVlanProtocolVlanTable • extremeVlanOpaqueTable • extremeStpDomainTable • extremeStpPortTable • extremeStpVlanPortTable • pethPsePortTable • extremePethSystem • extremePethPseSlotTable • extremePethPsePortTable
extremeSmartTrapInstanceTable		extremeSmartTrapInstanceTable is a read-only table that stores the information about which variables have changed according to rules defined in the extremeSmartTrapRulesTable.

EXTREME-V2TRAP-MIB

This MIB defines the following Extreme-specific SNMPv2c traps generated by Extreme Networks devices.

Trap	Comments
extremeHealthCheckFailed	CPU HealthCheck has failed.
extremeMsmFailoverTrap	MSM failover occurred.
extremeBgpM2PrefixReachedThreshold	This notification is generated when the number of prefixes received over this peer session reaches the threshold limit.
extremeBgpM2PrefixMaxExceeded	This notification is generated when the number of prefixes received over this peer session reaches the maximum configured limit.
extremeEapsStateChange	Send on master/transit nodes.
extremeEapsFailTimerExpFlagSet	This notification is generated when the EAPS domain fail timer expires for the first time, while its state is not in Fail state.
extremeEapsFailTimerExpFlagClear	This notification is generated when the EAPS domain fail timer expired flag is cleared.
extremeEapsLinkDownRingComplete	If a transit is in link-down state, and it receives a Health-Check-Pdu from the master indicating the ring is complete, there is some problem with the transit switch that has issued this trap message.
extremeEapsLastStatusChangeTime	Sent on master/transit nodes. Provides a general indication of a status change using a 10 second timer.
extremeEapsPortStatusChange	Sent on master/transit nodes.
extremeEapsConfigChange	Sent on master/transit nodes. This trap has a granularity of 30 seconds.
extremeEapsSharedPortStateChange	Sent on controller/partner nodes.
extremeEapsRootBlockerStatusChange	
extremeNMSInventoryChanged	These traps are not generated by the ExtremeXOS SNMP agent but by the Ridgeline NMS.
extremeNMSTopologyChanged	

EXTREME-VLAN-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremeVirtualGroup	extremeNextAvailableVirtIfIndex	
extremeVlanIfTable	extremeVlanIfIndex	While creating a new row in the extremeVlanIfTable, the value of the object extremeVlanIfDescr must be specified. For all tables in this MIB that contain objects with RowStatus semantics, the only values supported are: {active, createAndGo, destroy}.
	extremeVlanIfDescr	This is a description of the VLAN interface.
	extremeVlanIfType	The VLAN interface type.
	extremeVlanIfGlobalIdentifier	Not supported.

Table/Group	Supported Variables	Comments
	extremeVlanIfStatus	The status column for this VLAN interface. This object can be set to: <i>active</i> (1); <i>createAndGo</i> (4); <i>createAndWait</i> (5); <i>destroy</i> (6). The following values may be read: <i>active</i> (1); <i>notInService</i> (2); <i>notReady</i> (3).
	extremeVlanIfIgnoreStpFlag	Not supported.
	extremeVlanIfIgnoreBpduFlag	Not supported.
	extremeVlanIfLoopbackModeFlag	Setting this object to true causes loopback mode to be enabled on this VLAN.
	extremeVlanIfVlanId	The VLAN ID of this VLAN.
extremeGlobalMappingTable	Not supported	
extremeVlanEncapsTable	Not supported	
extremeVlanIpTable	All objects	For all tables in this MIB that contain objects with RowStatus semantics, the only values supported are: { <i>active</i> , <i>createAndGo</i> , and <i>destroy</i> }.
extremeVlanProtocolTable	Not supported	
extremeVlanProtocolBindingTable	Partial	For all tables in this MIB that contain objects with RowStatus semantics, the only values supported are: { <i>active</i> , <i>createAndGo</i> , and <i>destroy</i> }. New to the ExtremeXOS software: association of a protocol filter and VLAN.
extremeVlanProtocolVlanTable	Not supported	
extremeVlanProtocolDefTable	Partial	For all tables in this MIB that contain objects with RowStatus semantics, the only values supported are: { <i>active</i> , <i>createAndGo</i> , and <i>destroy</i> } New to the ExtremeXOS software: This is a new table introduced to add a protocol filter with etype values during creation of the filter itself.
extremeVlanOpaqueTable	All objects	This is a read only table. For adding ports to a VLAN or deleting ports from a VLAN, use extremeVlanOpaqueControlTable.
extremeVlanOpaqueControlTable	All objects	For all tables in this MIB that contain objects with RowStatus semantics, the only values supported are: { <i>active</i> , <i>createAndGo</i> , and <i>destroy</i> }. New to the ExtremeXOS software: extremeVlanOpaqueControlTable is a write only table and cannot be used to read. This is used to add/delete ports on a VLAN.
extremeVlanStackTable	All objects	Not supported.

Table/Group	Supported Variables	Comments
extremeVlanL2StatsTable	All objects	Not supported. This table contains per VLAN information about the number of packets sent to the CPU, the number of packets learned, the number of IGMP control packets snooped and the number of IGMP data packets switched. This is the same information that is available using the CLI command <code>show l2stats</code> .
extremePortVlanStatsTable		VLAN statistics per port.
extremePortVlanStatsEntry	extremeStatsPortIfIndex	The index of this table.
	extremeStatsVlanNameIndex	The index of this table.
	extremePortVlanStatsCntrType	Read-only.
	extremePortVlanTotalReceivedBytesCounter	The total number of bytes received by a port for a particular VLAN.
	extremePortVlanTotalReceivedFramesCounter	The total number of frames received by a port for a particular VLAN.
	extremePortVlanTotalTransmittedBytesCounter	The total number of bytes transmitted by a port for a particular VLAN.
	extremePortVlanTotalTransmittedFramesCounter	The total number of frames transmitted by a port for a particular VLAN.
	extremePortConfigureVlanStatus	The row status variable, used according to row installation and removal conventions.

EXTREME-VM-MIB

The following tables, groups, and variables are supported in this MIB.

Table/Group	Supported Variables	Comments
extremeVMFTPServerTable	extremeVMFTPServerEntry	
	extremeVMFTPServerType	The type of the FTP server. The backup server is contacted if the primary fails to respond.
	extremeVMFTPAddrType	The IP type of IP address.
	extremeVMFTPServer	The IP address of the FTP server used for transferring various management files.

	extremeVMFTPSynchInterval	The time in minutes between automatic synchronization attempts. A value of 0 indicates that automatic synchronizations are not performed. Note that each switch does not perform a synchronization at exactly the time configured, but varies the synchronization interval between 3/4 and 5/4 of the configured interval. This avoids the situation where all switches in a network attempt a synchronization at exactly the same moment. Automatic synchronization is disabled by default, and requests to enable them are rejected until the FTP server information (IPv4 or IPv6 address, username, and password) is configured.
	extremeVMFTPRowStatus	There can only be two entries in this table, one each for primary and secondary FTP servers.
	extremeVMFTPPathName	The FTP server directory name for the policies to be synchronized. A value of '/pub' is used by default.
	extremeVMFTPUsername	A valid username on the FTP server.
	extremeVMFTPPassword	The password associated with the FTP user. This object returns a zero length string when queried.
extremeVMGeneral	extremeVMFTPPolicyDir	The server directory name for the policies to be synchronized. A value of '/' is used by default.
	extremeVMLastSynch	The timestamp of the most recent synchronization attempt.
	extremeVMLastSynchStatus	The result of the most recent synchronization attempt: <ul style="list-style-type: none"> • success (1)—indicates that the synchronization completed successfully • accessDenied (2)—The username and password were not accepted by the server • serverTimeout (3)—Could not establish a file transfer session with the configured server • serverNotConfigured (4)—The server configuration is not complete

	extremeVMSynchAdminState	Triggers a synchronization cycle on demand. A synchronization automatically downloads new or updated policies as well as delete policies to match those on the server: <ul style="list-style-type: none"> idle (1) is returned whenever this object is read. synchronizeNow (2) triggers an immediate synchronization, and is reflected in extremeVMSynchOperState. Attempts to set this variable to synchronizeNow (2) are rejected if a synchronization is currently in progress.
	extremeVMSynchOperState	Indicates if a synchronization is in progress, either on-demand or automatic.
	extremeVMTrackingEnabled	The virtual machine (VM) tracking feature is disabled by default and can be enabled using this object.
	extremeVMPortConfigTable	Configures the VM features on each port.
extremeVMPortConfigEntry		An entry in the table for VM features on each port.
	extremeVMPortConfigIfIndex	The value of ifIndex of a physical port capable of supporting the VM tracking features.
	extremeVMPortConfigVMTrackingEnabled	Enables the VM tracking feature on a port. The VM tracking feature is disabled by default.
extremeVMVPPTable		This table contains port policies contained within this switch. Port policies come in two variants: network and local. Network policies are downloaded from the FTP server; local policies reside only within a single switch.
extremeVMVPPEntry		An entry in the table of VM policy information of this device. This table is populated with two sets of policies, those downloaded from the policy server and those defined locally on this switch.
	extremeVMVPPType	The type of the port policy. Network port policies are obtained from a central policy store. Local policies are specific to this particular switch.
	extremeVMVPPName	The name of the port VPP. VPP names must be alpha-numeric and must start with an alpha character.
	extremeVMVPPControl	Performs the requested operation on this policy. <i>synchronizeNow</i> (1) downloads a copy of the policy from the FTP server. (Network policies only). This object returns <i>noOperation</i> (2) if read.
	extremeVMVPPRowStatus	Only local VPPs can be created or deleted.
extremeVMMappingTable		This table contains the mapping of port policies to VM MAC addresses.

	extremeVMMMappingEntry	An entry in the table of VM information of this device.
	extremeVMMMappingType	The type of mapping for this entry. A local mapping exists only on this specific switch. A network mapping is one obtained through a download of a mapping file.
	extremeVMMMappingMAC	The MAC address associated with the VM. Note that a VM can have multiple MAC addresses.
	extremeVMMMappingIngressVPPName	<p>The ingress policy associated with the VM/MAC address. Note that this may refer to a policy without a corresponding entry in the extremeVMVPPTable if a network policy mapping refers to a non-existent policy. This indicates an error in the policy mapping file that is consulted if network authentication fails.</p> <p>When creating an entry in this table, this name must refer to an existing, valid, local policy. The creation of a mapping to a network policy is not permitted. Those mappings must be created at the central policy server.</p>
	extremeVMMMappingEgressVPPName	<p>The egress policy associated with the VM/MAC address. Note that this might refer to a policy without a corresponding entry in the extremeVMVPPTable if a network policy mapping refers to a non-existent policy. This indicates an error in the policy mapping file that is consulted if network authentication fails.</p> <p>When creating an entry in this table, this name must refer to an existing, valid, local policy. The creation of a mapping to a network policy is not permitted. Those mappings must be created at the central policy server.</p>
	extremeVMMMappingStatus	<p>Indicates the virtual port profile mapping status:</p> <ul style="list-style-type: none"> • vppValid (1)—A VPP mapped to this VM MAC address does not have any policies associated with it (or) all the policies associated with this VPP can be applied (policy validation is success). Policy validation will happen only when this VM MAC is detected. • vppMissing (2)—This value is applicable only for network VM if the specified VPP name was missing. • vppInvalid (3)—One of the policies mapped to VPP cannot be applied (policy validation failed) because the policy file contains one or more errors that prevent it from being applied • vppNotMapped (4)—The VM does not have any VPP mapped.

	extremeVMMappingRowStatus	Only local polices can be created or deleted.
	extremeVMMappingVPPName	The virtual port profile associated with the VM MAC address. When creating an entry in this table, this name must refer to an existing, valid, local profile. The creation of a mapping to a network profile is not permitted. Those mappings must be created at the central policy server.
extremeVMVPP2PolicyTable		This table contains the mapping of a VPP to individual policies.
extremeVMVPP2PolicyEntry		An individual mapping of VPP to policy.
	extremeVMVPP2PolicyVPPName	The name of the VPP.
	extremeVMVPP2PolicyPolicyName	The name of the local policy.
	extremeVMVPP2PolicyType	The type of policy
	extremeVMVPP2PolicyOrder	The order in which this policy is executed.
	extremeVMVPP2PolicyRowStatus	The row status for this mapping.
extremeVMDetected	extremeVMDetectedNumber	The number of VMs detected on this switch.
extremeVMDetectedTable		This table contains the currently detected VMs on this switch.
extremeVMDetectedEntry		An entry in the table of VM information of this device.
	extremeVMDetectedMAC	The MAC address associated with the VM. Note that a VM can have multiple MAC addresses.
	extremeVMDetectedVMName	The name of the VM. Note that a VM authenticated locally might not have a name.
	extremeVMDetectedIngressVPPName	The name of the policy applied (or attempted to apply) to this VM.
	extremeVMDetectedEgressVPPName	The name of the policy applied (or attempted to apply) to this VM.
	extremeVMDetectedIfIndex	The value of ifIndex on which this VM was detected.
	extremeVMDetectedAdminStatus	The administrative status of the VM authentication. Setting this variable to <i>authenticating</i> (1) will force the re-authentication of the VM. This variable always returns <i>idle</i> (2) when read.

	extremeVMDetectedOperStatus	<p>The authentication status of the VM:</p> <ul style="list-style-type: none"> • authenticating (1)—an authentication is currently in progress • authenticatedNetwork (2)—the VM has been authenticated by a network source • authenticatedLocally (3)—the VM has been authenticated by the local database • denied (4)—the VM was explicitly denied entry • notAuthenticated (5)—the authentication process timed out or was never attempted
	extremeVMDetectedResultIngress	<p>Indicates the result of a VM entry into the network. Only the two values below will be returned at any point of time:</p> <ul style="list-style-type: none"> • policyApplied (1)—All the ingress policies in the VPP were successfully applied to the port. • policyNotApplied (2) - One of the ingress policies in the VPP was not applied to the port. If this value is returned then refer to the extremeVMDetectedIngErrPolicies object for list of failed ingress policies.
	extremeVMDetectedResultEgress	<p>Indicates the result of a VM entry into the network. Only the two values below will be returned at any point of time:</p> <ul style="list-style-type: none"> • policyApplied (1) - All the egress policies in the VPP were successfully applied to the port. • policyNotApplied (2) - One of the egress policies in the VPP was not applied to the port. If this value is returned then refer to the extremeVMDetectedEgrErrPolicies object for list of failed egress policies.
	extremeVMDetectedIngErrPolicies	Displays the list of failed ingress policies.
	extremeVMDetectedEgrErrPolicies	Displays the list of failed egress policies.
	extremeVMDetectedVPPName	The name of the VPP applied (or attempted to apply) to this VM.
	extremeVMDetectedVPPResult	<p>Indicates the result of a VPP associated with a VM MAC:</p> <ul style="list-style-type: none"> • vppMapped (1)—indicates that the named VPP was mapped. • vppNotMapped (2)—indicates that the no VPP was mapped. • vppInvalid (3)—indicates that the VPP mapped was invalid. • vppMissing (4)—indicates that the VPP mapped was missing

extremeVMVPPDetailTable		This table contains the mapping of a VPP to individual policies.
extremeVMVPPDetailEntry		A set of mappings from a VPP to one or more policies.
	extremeVMVPPDetailVPPName	The name of the VPP.
	extremeVMVPPDetailDirection	The direction in which the policy is applied.
	extremeVMVPPDetailType	The type of policy
	extremeVMVPPDetailOrder	The order in which this policy is executed.
	extremeVMVPPDetailPolicyName	The name of the local policy
	extremeVMVPPDetailRowStatus	The row status for this mapping.
extremeVMVPPSynchType		Indicates the type of policy

The following traps can be generated.

Trap	Notification Objects	Comments
extremeVMNotificationPrefix	extremeVMVPPSyncFailed	A synchronization attempt failed.
	extremeVMVPPInvalid	A VPP definition is invalid, indicating it cannot be applied to a port.
	extremeVMMapped	This notification is generated whenever a MAC address is manually mapped to a local policy.
	extremeVMUnMapped	This notification is generated whenever a MAC address is manually unmapped to a local policy.
	extremeVMDetectResult	This notification is generated after a VM is detected on a port and reflects the result of that operation.
	extremeVMUnDetectResult	This notification is generated after a VM is undetected (removed) from a port.

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Glossary

A

AAA	Authentication, authorization, and accounting. A system to control which computer resources specific users can access and to keep track of the activity of specific users over the network.
ABR	Area border router. In OSPF, an ABR has interfaces in multiple areas, and it is responsible for exchanging summary advertisements with other ABRs.
ACL	Access Control List. ACLs are a mechanism for filtering packets at the hardware level. Packets can be classified by characteristics such as the source or destination MAC, IP addresses, IP type, or QoS queue. Once classified, the packets can be forwarded, counted, queued, or dropped. In Extreme Networks XOS software, you configure ACLs by creating a file, called a policy file (with a <i>.pol</i> file extension). The system parses the policy file and loads the ACL into the hardware.
ACMI	Asynchronous Chassis Management Interface.
alternate port	In RSTP, the alternate port supplies an alternate path to the root bridge and the root port.
AP	Access point. In wireless technology, access points are the devices that connect to the regular wired network and forward and receive the radio signals that transmit wireless data.
area	In OSPF, an area is a logical set of segments connected by routers. The topology within an area is hidden from the rest of the AS.
ARP	Address Resolution Protocol. ARP is part of the TCP/IP suite used to dynamically associate a device's physical address (MAC address) with its logical address (IP address). The system broadcasts an ARP request, containing the IP address, and the device with that IP address sends back its MAC address so that traffic can be transmitted.
AS	Autonomous system. In OSPF, an AS is a connected segment of a network topology that consists of a collection of subnetworks (with hosts attached) interconnected by a set of routes. The subnetworks and the routers are expected to be under the control of a single administration. Within an AS, routers may use one or more interior routing protocols and sometimes several sets of metrics. An AS is expected to present to other ASs an appearance of a coherent interior routing plan and a consistent picture of the destinations reachable through the AS. An AS is identified by a unique 16-bit number.
ASBR	Autonomous system border router. In OSPF, an ASBR acts as a gateway between OSPF and other routing protocols or other ASs.

A (Continued)

autobind	In STP, autobind, when enabled, automatically adds or removes ports from the STPD. If ports are added to the carrier VLAN, the member ports of the VLAN are automatically added to the STPD. If ports are removed from the carrier VLAN, those ports are also removed from the STPD.
autonegotiation	As set forth in IEEE 802.3u, autonegotiation allows each port on the switch—in partnership with its link partner—to select the highest speed between 10 Mbps and 100 Mbps and the best duplex mode.
AVS	Auto Voltage Sensor.

B

backbone area	In OSPF, a network that has more than one area must have a backbone area, configured as 0.0.0.0. All areas in an AS must connect to the backbone area.
backup port	In RSTP, the backup port supports the designated port on the same attached LAN segment. Backup ports exist only when the bridge is connected as a self-loop or to a shared media segment.
backup router	In VRRP, the backup router is any VRRP router in the VRRP virtual router that is not elected as the master. The backup router is available to assume forwarding responsibility if the master becomes unavailable.
BDR	Backup designated router. In OSPF, the system elects a DR and a BDR. The BDR smooths the transition to the DR, and each multiaccess network has a BDR. The BDR is adjacent to all routers on the network and becomes the DR when the previous DR fails. The period of disruption in transit traffic lasts only as long as it takes to flood the new LSAs (which announce the new DR). The BDR is elected by the protocol; each hello packet has a field that specifies the BDR for the network.
BGP	Border Gateway Protocol. BGP is a router protocol in the IP suite designed to exchange network reachability information with BGP systems in other ASs. You use a fully meshed configuration with BGP. BGP provides routing updates that include a network number, a list of ASs that the routing information passed through, and a list of other path attributes. BGP works with cost metrics to choose the best available path; it sends updated router information only when one host has detected a change, and only the affected part of the routing table is sent. BGP communicates <i>within</i> one AS using Interior BGP (IBGP) because BGP does not work well with IGP. The routers inside the AS thus maintain two routing tables: one for the IGP and one for IBGP. BGP uses exterior BGP (EBGP) <i>between</i> different ASs.
bi-directional rate shaping	This is a hardware-based technology that allows you to manage bandwidth on Layer 2 and Layer 3 traffic flowing to each port on the switch and to the backplane, per physical port on the I/O module. The parameters differ across platforms and modules.

B (Continued)

blackhole	In the Extreme Networks implementation, you can configure the switch so that traffic is silently dropped. Although this traffic appears as received, it does not appear as transmitted (because it is dropped).
BOOTP	Bootstrap Protocol. BOOTP is an Internet protocol used by a diskless workstation to discover its own IP address, the IP address of a BOOTP server on the network, and a file that can be loaded into memory to boot the machine. Using BOOTP, a workstation can boot without a hard or floppy disk drive.
BPDU	Bridge protocol data unit. In STP, a BPDU is a packet that initiates communication between devices. BPDU packets contain information on ports, addresses, priorities, and costs and ensure that the data ends up where it was intended to go. BPDU messages are exchanged across bridges to detect loops in a network topology. The loops are then removed by shutting down selected bridge interfaces and placing redundant switch ports in a backup, or blocked, state.
bridge	<p>In conventional networking terms, bridging is a Layer 2 function that passes frames between two network segments; these segments have a common network layer address. The bridged frames pass only to those segments connected at a Layer 2 level, which is called a broadcast domain (or VLAN). You must use Layer 3 routing to pass frames between broadcast domains (VLANs).</p> <p>In wireless technology, bridging refers to forwarding and receiving data between radio interfaces on APs or between clients on the same radio. So, bridged traffic can be forwarded from one AP to another AP without having to pass through the switch on the wired network.</p>
broadcast	A broadcast message is forwarded to all devices within a VLAN, which is also known as a broadcast domain. The broadcast domain, or VLAN, exists at a Layer 2 level; you must use Layer 3 routing to communicate between broadcast domains, or VLANs. Thus, broadcast messages do not leave the VLAN. Broadcast messages are identified by a broadcast address.

C

carrier VLAN	In STP, carrier VLANs define the scope of the STPD, including the physical and logical ports that belong to the STPD as well as the 802.1Q tags used to transport EMISTP- or PVST+-encapsulated BPDUs. Only one carrier VLAN can exist in any given STPD.
CCM	In CFM, connectivity check messages are CFM frames transmitted periodically by a MEP to ensure connectivity across the maintenance entities to which the transmitting MEP belongs. The CCM messages contain a unique ID for the specified domain. Because a failure to receive a CCM indicates a connectivity fault in the network, CCMs proactively check for network connectivity.
CFM	Connectivity Fault Management allows an ISP to proactively detect faults in the network for each customer service instance individually and separately. CFM comprises capabilities for detecting, verifying, and isolating connectivity failures in virtual bridged LANs.

C (Continued)

checkpointing	Checkpointing is the process of copying the active state configurations from the primary MSM to the backup MSM on modular switches.
CIDR	Classless Inter-Domain Routing. CIDR is a way to allocate and specify the Internet addresses used in interdomain routing more flexibly than with the original system of IP address classes. This address aggregation scheme uses supernet addresses to represent multiple IP destinations. Rather than advertise a separate route for each destination, a router uses a supernet address to advertise a single route representing all destinations. RIP does not support CIDR; BGP and OSPF support CIDR.
CIST	Common and Internal Spanning Tree. In an MSTP environment, the CIST is a single spanning tree domain that connects MSTP regions. The CIST is responsible for creating a loop-free topology by exchanging and propagating BPDUs across MSTP regions. You can configure only one CIST on each switch.
CIST root port	In an MSTP environment, the port on the CIST regional root bridge that connects to the CIST root bridge is the CIST root port. The CIST root port is the master port for all MSTIs in that MSTP region, and it is the only port that connects the entire region to the CIST root bridge.
CIST regional root bridge	Within an MSTP region, the bridge with the lowest path cost to the CIST root bridge is the CIST regional root bridge. If the CIST root bridge is inside an MSTP region, that same bridge is the CIST regional root for that region because it has the lowest path cost to the CIST root. If the CIST root bridge is outside an MSTP region, all regions connect to the CIST root through their respective CIST regional roots.
CIST root bridge	In an MSTP environment, the bridge with the lowest bridge ID becomes the CIST root bridge. The bridge ID includes the bridge priority and the MAC address. The CIST root bridge can be either inside or outside an MSTP region. The CIST root bridge is unique for all regions and non-MSTP bridges, regardless of its location.
CLEAR-Flow	CLEAR-Flow allows you to specify certain types of traffic to perform configured actions on. You can configure the switch to take an immediate, preconfigured action to the specified traffic or to send a copy of the traffic to a management station for analysis. CLEAR-Flow is an extension to ACLs, so you must be familiar with ACL policy files to apply CLEAR-Flow.
CLI	Command line interface. You use the CLI to monitor and manage the switch.
cluster	In BGP, a cluster is formed within an AS by a route reflector and its client routers.
CNA	Converged Network Analyzer. This application suite, available from Avaya, allows the server to determine the best possible network path. The CNA Agent is a software piece of the entire CNA application that you install on Extreme Networks devices. You use the CNA Agent software <i>only</i> if you are using the Avaya CNA solution, and the CNA Agent cannot function unless you also obtain the rest of the CNA application from Avaya.

C (Continued)

combo port	Combination port. On some Extreme Networks devices (such as the Summit X450 a-series switch), certain ports can be used as <i>either</i> copper or fiber ports.
common link	In EAPS, the common link is the physical link between the controller and partner nodes in a network where multiple EAPS share a common link between domains.
controller node	In EAPS, the controller node is that end of the common line that is responsible for blocking ports if the common link fails, thereby preventing a superloop.
control VLAN	In EAPS, the control VLAN is a VLAN that sends and receives EAPS messages. You must configure one control VLAN for each EAPS domain.
CoS	Class of Service. Specifying the service level for the classified traffic type.
CRC	Cyclic redundancy check. This simple checksum is designed to detect transmission errors. A decoder calculates the CRC for the received data and compares it to the CRC that the encoder calculated, which is appended to the data. A mismatch indicates that the data was corrupted in transit.
CRC error	Cyclic redundancy check error. This is an error condition in which the data failed a checksum test used to trap transmission errors. These errors can indicate problems anywhere in the transmission path.
CSPF	Constrained shortest path first. An algorithm based on the shortest path first algorithm used in OSPF, but with the addition of multiple constraints arising from the network, the LSP, and the links. CSPF is used to minimize network congestion by intelligently balancing traffic.

D

DA	Destination address. The DA is the IP or MAC address of the device that is to receive the packet.
DAD	Duplicate Address Detection. IPv6 automatically uses this process to ensure that no duplicate IP addresses exist.
DCB	Data Center Bridging is a set of IEEE 802.1Q extensions to standard Ethernet, that provide an operational framework for unifying Local Area Networks (LAN), Storage Area Networks (SAN) and Inter-Process Communication (IPC) traffic between switches and endpoints onto a single transport layer.
DCBX	The Data Center Bridging eXchange protocol is used by DCB devices to exchange DCB configuration information with directly connected peers.

D (Continued)

default encapsulation mode	<p>In STP, default encapsulation allows you to specify the type of BPDU encapsulation to use for all ports added to a given STPD, not just to one individual port. The encapsulation modes are:</p> <ul style="list-style-type: none">● 802.1d—This mode is used for backward compatibility with previous STP versions and for compatibility with third-party switches using IEEE standard 802.1d.● EMISTP—Extreme Multiple Instance Spanning Tree Protocol (EMISTP) mode is an extension of STP that allows a physical port to belong to multiple STPDs by assigning the port to multiple VLANs.● PVST+—This mode implements PVST+ in compatibility with third-party switches running this version of STP.
designated port	<p>In STP, the designated port provides the shortest path connection to the root bridge for the attached LAN segment. Each LAN segment has only one designated port.</p>
Device Manager	<p>The Device Manager is an Extreme Networks-proprietary process that runs on every node and is responsible for monitoring and controlling all of the devices in the system. The Device Manager is useful for system redundancy.</p>
DF	<p>Don't fragment bit. This is the don't fragment bit carried in the flags field of the IP header that indicates that the packet should not be fragmented. The remote host will return ICMP notifications if the packet had to be split anyway, and these are used in MTU discovery.</p>
DHCP	<p>Dynamic Host Configuration Protocol. DHCP allows network administrators to centrally manage and automate the assignment of IP addresses on the corporate network. DHCP sends a new IP address when a computer is plugged into a different place in the network. The protocol supports static or dynamic IP addresses and can dynamically reconfigure networks in which there are more computers than there are available IP addresses.</p>
DiffServ	<p>Differentiated Services. Defined in RFC 2474 and 2475, DiffServ is an architecture for implementing scalable service differentiation in the Internet. Each IP header has a DiffServ (DS) field, formerly known as the Type of Service (TOS) field. The value in this field defines the QoS priority the packet will have throughout the network by dictating the forwarding treatment given to the packet at each node. DiffServ is a flexible architecture that allows for either end-to-end QoS or intradomain QoS by implementing complex classification and mapping functions at the network boundary or access points. In the Extreme Networks implementation, you can configure the desired QoS by replacing or mapping the values in the DS field to egress queues that are assigned varying priorities and bandwidths.</p>
DNS	<p>Domain Name Server. This system is used to translate domain names to IP addresses. Although the Internet is based on IP addresses, names are easier to remember and work with. All these names must be translated back to the actual IP address and the DNS servers do so.</p>

D (Continued)

domain	In CFM, a maintenance domain is the network, or part of the network, that belongs to a single administration for which connectivity faults are managed.
DoS attack	Denial of service attacks occur when a critical network or computing resource is overwhelmed so that legitimate requests for service cannot succeed. In its simplest form, a DoS attack is indistinguishable from normal heavy traffic. ExtremeXOS software has configurable parameters that allow you to defeat DoS attacks.
DR	Designated router. In OSPF, the DR generates an LSA for the multiaccess network and has other special responsibilities in the running of the protocol. The DR is elected by the OSPF protocol.
dropped packets	These are packets that the switch received but does not transmit.

E

EAPS	Extreme Automatic Protection Switching. EAPS is an Extreme Networks-proprietary protocol that prevents looping Layer 2 of the network. This feature is discussed in RFC 3619.
EAPS domain	An EAPS domain consists of a series of switches, or nodes, that comprise a single ring in a network. An EAPS domain consists of a master node and transit nodes. The master node consists of one primary and one secondary port. EAPS operates by declaring an EAPS domain on a single ring.
EAPS link ID	Each common link in the EAPS network must have a unique link ID. The controller and partner shared ports belonging to the same common link must have matching link IDs, and not other instance in the network should have that link ID.
EBGP	Exterior Border Gateway Protocol. EBGP is a protocol in the IP suite designed to exchange network reachability information with BGP systems in other ASs. EBGP works between different ASs.
ECMP	Equal Cost Multi Paths. This routing algorithm distributes network traffic across multiple high-bandwidth OSPF, BGP, IS-IS, and static routes to increase performance. The Extreme Networks implementation supports multiple equal cost paths between points and divides traffic evenly among the available paths.
edge ports	In STP, edge ports connect to non-STP devices such as routers, endstations, and other hosts.
EDP	Extreme Discovery Protocol. EDP is a protocol used to gather information about neighbor Extreme Networks switches. Extreme Networks switches use EDP to exchange topology information.
EEPROM	Electrically erasable programmable read-only memory. EEPROM is a memory that can be electronically programmed and erased but does not require a power source to retain data.

E (Continued)

EGP	Exterior Gateway Protocol. EGP is an Internet routing protocol for exchanging reachability information between routers in different ASs. BGP is a more recent protocol that accomplishes this task.
election algorithm	In ESRP, this is a user-defined criteria to determine how the master and slave interact. The election algorithm also determines which device becomes the master or slave and how ESRP makes those decisions.
ELSM	Extreme Link Status Monitoring. ELSM is an Extreme Networks-proprietary protocol that monitors network health. You can also use ELSM with Layer 2 control protocols to improve Layer 2 loop recovery in the network.
ELRP	Extreme Loop Recovery Protocol. ELRP is an Extreme Networks-proprietary protocol that allows you to detect Layer 2 loops.
EMISTP	Extreme Multiple Instance Spanning Tree Protocol. This Extreme Networks-proprietary protocol uses a unique encapsulation method for STP messages that allows a physical port to belong to multiple STPDs.
EMS	Event Management System. This Extreme Networks-proprietary system saves, displays, and filters events, which are defined as any occurrences on a switch that generate a log message or require action.
encapsulation mode	Using STP, you can configure ports within an STPD to accept specific BPDU encapsulations. The three encapsulation modes are: <ul style="list-style-type: none">● 802.1D—This mode is used for backward compatibility with previous STP versions and for compatibility with third-party switches using IEEE standard 802.1D.● EMISTP—Extreme Multiple Instance Spanning Tree Protocol mode is an extension of STP that allows a physical port to belong to multiple STPDs by assigning the port to multiple VLANs.● PVST+—This mode implements PVST+ in compatibility with third-party switches running this version of STP.
EPICenter	See Ridgeline.
ESRP	Extreme Standby Router Protocol. ESRP is an Extreme Networks-proprietary protocol that provides redundant Layer 2 and routing services to users.
ESRP-aware device	This is an Extreme Networks device that is not running ESRP itself but that is connected on a network with other Extreme Networks switches that are running ESRP. These ESRP-aware devices also fail over.
ESRP domain	An ESRP domain allows multiple VLANs to be protected under a single logical entity. An ESRP domain consists of one domain-master VLAN and zero or more domain-member VLANs.
ESRP-enabled device	An ESRP-enabled device is an Extreme Networks switch with an ESRP domain and ESRP enabled. ESRP-enabled switches include the ESRP master and slave switches.

E (Continued)

ESRP groups	An ESRP group runs multiple instances of ESRP within the same VLAN (or broadcast domain). To provide redundancy at each tier, use a pair of ESRP switches on the group.
ESRP instance	You enable ESRP on a per domain basis; each time you enable ESRP is an ESRP instance.
ESRP VLAN	A VLAN that is part of an ESRP domain, with ESRP enabled, is an ESRP VLAN.
Ethernet	This is the IEEE 802.3 networking standard that uses carrier sense multiple access with collision detection (CSMA/CD). An Ethernet device that wants to transmit first checks the channel for a carrier, and if no carrier is sensed within a period of time, the device transmits. If two devices transmit simultaneously, a collision occurs. This collision is detected by all transmitting devices, which subsequently delay their retransmissions for a random period. Ethernet runs at speeds from 10 Mbps to 10 Gbps on full duplex.
extended mode	ESRP extended mode supports and is compatible only with switches running ExtremeXOS software exclusively.

F

Fast Convergence	In EAPS, Fast Convergence allows convergence in less than 50 milliseconds. You configure this parameter for the entire switch, not by EAPS domain.
fast path	This term refers to the data path for a packet that traverses the switch and does not require processing by the CPU. Fast path packets are handled entirely by ASICs and are forwarded at wire speed rate.
FDB	Forwarding database. The switch maintains a database of all MAC address received on all of its ports and uses this information to decide whether a frame should be forwarded or filtered. Each FDB entry consists of the MAC address of the sending device, an identifier for the port on which the frame was received, and an identifier for the VLAN to which the device belongs. Frames destined for devices that are not currently in the FDB are flooded to all members of the VLAN. For some types of entries, you configure the time it takes for the specific entry to age out of the FDB.
FIB	Forwarding Information Base. On BlackDiamond 8800 series switches and Summit family switches, the Layer 3 routing table is referred to as the FIB.
FM	Fabric Module.
frame	This is the unit of transmission at the data link layer. The frame contains the header and trailer information required by the physical medium of transmission.

F (Continued)

full-duplex This is the communication mode in which a device simultaneously sends and receives over the same link, doubling the bandwidth. Thus, a full-duplex 100 Mbps connection has a bandwidth of 200 Mbps, and so forth. A device either automatically adjusts its duplex mode to match that of a connecting device or you can configure the duplex mode; all devices at 1 Gbps or higher run *only* in full-duplex mode.

G

Gigabit Ethernet This is the networking standard for transmitting data at 1000 Mbps or 1 Gbps. Devices can transmit at multiples of gigabit Ethernet as well.

H

HA Host Attach. In ExtremeXOS software, HA is part of ESRP that allows you to connect active hosts directly to an ESRP switch; it allows configured ports to continue Layer 2 forwarding regardless of their ESRP status.

half-duplex This is the communication mode in which a device can either send or receive data, but not simultaneously. (Devices at 1 Gbps or higher do not run in half-duplex mode; they run only in full-duplex mode.)

header This is control information (such as originating and destination stations, priority, error checking, and so forth) added in front of the data when encapsulating the data for network transmission.

hitless failover In the Extreme Networks implementation on modular switches, hitless failover means that designated configurations survive a change of primacy between the two MSMs with all details intact. Thus, those features run seamlessly during and after control of the system changes from one MSM to another.

I

IBGP Interior Border Gateway Protocol. IBGP is the BGP version used within an AS.

ICMP Internet Control Message Protocol. ICMP is the part of the TCP/IP protocol that allows generation of error messages, test packets, and operating messages. For example, the `ping` command allows you to send ICMP echo messages to a remote IP device to test for connectivity. ICMP also supports traceroute, which identifies intermediate hops between a given source and destination.

IEEE Institute of Electrical and Electronic Engineers. This technical professional society fosters the development of standards that often become national and international standards. The organization publishes a number of journals and has many local chapters and several large societies in special areas.

I (Continued)

IETF	Internet Engineering Task Force. The IETF is a large, open, international community of network designers, operators, vendors, and researchers concerned with the evolution of the Internet architecture and the smooth operation of the Internet. The technical work of the IETF is done in working groups, which are organized by topic.
IGMP	Internet Group Management Protocol. Hosts use IGMP to inform local routers of their membership in multicast groups. Multicasting allows one computer on the Internet to send content to multiple other computers that have identified themselves as interested in receiving the originating computer's content. When all hosts leave a group, the router no longer forwards packets that arrive for the multicast group.
IGMP snooping	This provides a method for intelligently forwarding multicast packets within a Layer 2 broadcast domain. By "snooping" the IGMP registration information, the device forms a distribution list that determines which endstations receive packets with a specific multicast address. Layer 2 switches listen for IGMP messages and build mapping tables and associated forwarding filters. IGMP snooping also reduces IGMP protocol traffic.
IGP	Interior Gateway Protocol. IGP refers to any protocol used to exchange routing information within an AS. Examples of Internet IGPs include RIP and OSPF.
inline power	According to IEEE 802.3 af, inline power refers to providing an AC or DC power source through the same cable as the data travels. It allows phones and network devices to be placed in locations that are not near AC outlets. Most standard telephones use inline power.
IP	Internet Protocol. The communications protocol underlying the Internet, IP allows large, geographically diverse networks of computers to communicate with each other quickly and economically over a variety of physical links; it is part of the TCP/IP suite of protocols. IP is the Layer 3, or network layer, protocol that contains addressing and control information that allows packets to be routed. IP is the most widely used networking protocol; it supports the idea of unique addresses for each computer on the network. IP is a connectionless, best-effort protocol; TCP reassembles the data after transmission. IP specifies the format and addressing scheme for each packet.
IPv6	Internet Protocol version 6. IPv6 is the next-generation IP protocol. The specification was completed in 1997 by IETF. IPv6 is backward-compatible with and is designed to fix the shortcomings of IPv4, such as data security and maximum number of user addresses. IPv6 increases the address space from 32 to 128 bits, providing for an unlimited (for all intents and purposes) number of networks and systems; IPv6 is expected to slowly replace IPv4, with the two existing side by side for many years.

I (Continued)

IP address	IP address is a 32-bit number that identifies each unique sender or receiver of information that is sent in packets; it is written as four octets separated by periods (dotted-decimal format). An IP address has two parts: the identifier of a particular network and an identifier of the particular device (which can be a server or a workstation) within that network. You may add an optional subnetwork identifier. Only the network part of the address is looked at between the routers that move packets from one point to another along the network. Although you can have a static IP address, many IP addresses are assigned dynamically from a pool. Many corporate networks and online services economize on the number of IP addresses they use by sharing a pool of IP addresses among a large number of users. (The format of the IP address is slightly changed in IPv6.)
IPTV	Internal Protocol television. IPTV uses a digital signal sent via broadband through a switched telephone or cable system. An accompanying set top box (that sits on top of the TV) decodes the video and converts it to standard television signals.
IR	Internal router. In OSPF, IR is an internal router that has all interfaces within the same area.
IRDP	Internet Router Discovery Protocol. Used with IP, IRDP enables a host to determine the address of a router that it can use as a default gateway. In Extreme Networks implementation, IP multinetting requires a few changes for the IRDP.
ISO	This abbreviation is commonly used for the International Organization for Standardization, although it is not an acronym. ISO was founded in 1946 and consists of standards bodies from more than 75 nations. ISO had defined a number of important computer standards, including the OSI reference model used as a standard architecture for networking.
ISP	An Internet Service Provider is an organization that provides access to the Internet. Small ISPs provide service via modem and ISDN while the larger ones also offer private line hookups (T1, fractional T1, etc.). Customers are generally billed a fixed rate per month, but other charges may apply. For a fee, a Web site can be created and maintained on the ISP's server, allowing the smaller organization to have a presence on the Web with its own domain name.
ITU-T	International Telecommunication Union-Telecommunication. The ITU-T is the telecommunications division of the ITU international standards body.

J

jumbo frames	These are Ethernet frames that are larger than 1522 bytes (including the 4 bytes in the CRC). The jumbo frame size is configurable on Extreme Networks devices; the range is from 1523 to 9216 bytes.
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L

LACP	Link Aggregation Control Protocol. LACP is part of the IEEE 802.3ad and automatically configures multiple aggregated links between switches.
LAG	Link aggregation group. A LAG is the logical high-bandwidth link that results from grouping multiple network links in link aggregation (or load sharing). You can configure static LAGs or dynamic LAGs (using the LACP).
Layer 2	Layer 2 is the second, or data link, layer of the OSI model, or the MAC layer. This layer is responsible for transmitting frames across the physical link by reading the hardware, or MAC, source and destination addresses.
Layer 3	Layer 3 is the third layer of the OSI model. Also known as the network layer, Layer 3 is responsible for routing packets to different LANs by reading the network address.
LED	Light-emitting diode. LEDs are on the device and provide information on various states of the device's operation. See your hardware documentation for a complete explanation of the LEDs on devices running ExtremeXOS.
license	ExtremeXOS version 11.1 introduces a licensing feature to the ExtremeXOS software. You must have a license, which you obtain from Extreme Networks, to apply the full functionality of some features.
link aggregation	Link aggregation, also known as trunking or load sharing, conforms to IEEE 802.3ad. This feature is the grouping of multiple network links into one logical high-bandwidth link.
link type	In OSPF, there are four link types that you can configure: auto, broadcast, point-to-point, and passive.
LLDP	Link Layer Discovery Protocol. LLDP conforms to IEEE 802.1ab and is a neighbor discovery protocol. Each LLDP-enabled device transmits information to its neighbors, including chassis and port identification, system name and description, VLAN names, and other selected networking information. The protocol also specifies timing intervals in order to ensure current information is being transmitted and received.
load sharing	Load sharing, also known as trunking or link aggregation, conforms to IEEE 802.3ad. This feature is the grouping of multiple network links into one logical high-bandwidth link. For example, by grouping four 100 Mbps of full-duplex bandwidth into one logical link, you can create up to 800 Mbps of bandwidth. Thus, you increase bandwidth and availability by using a group of ports to carry traffic in parallel between switches.
LFS	Link Fault Signal. LFS, which conforms to IEEE standard 802.3ae-2002, monitors 10 Gbps ports and indicates either remote faults or local faults.

L (Continued)

loop detection	In ELRP, loop detection is the process used to detect a loop in the network. The switch sending the ELRP PDU waits to receive its original PDU back. If the switch received this original PDU, there is a loop in the network.
LSA	Link state advertisement. An LSA is a broadcast packet used by link state protocols, such as OSPF. The LSA contains information about neighbors and path costs and is used by the receiving router to maintain a routing table.
LSDB	Link state database. In OSPF, LSDB is a database of information about the link state of the network. Two neighboring routers consider themselves to be adjacent only if their LSDBs are synchronized. All routing information is exchanged only between adjacent routers.

M

MAC address	Media access control address. The MAC address, sometimes known as the hardware address, is the unique physical address of each network interface card on each device.
MAN	Metropolitan area network. A MAN is a data network designed for a town or city. MANs may be operated by one organization such as a corporation with several offices in one city, or be shared resources used by several organizations with several locations in the same city. MANs are usually characterized by very high-speed connections.
master node	In EAPS, the master node is a switch, or node, that is designated the master in an EAPS domain ring. The master node blocks the secondary port for all non-control traffic belonging to this EAPS domain, thereby avoiding a loop in the ring.
master router	In VRRP, the master router is the physical device (router) in the VRRP virtual router that is responsible for forwarding packets sent to the VRRP virtual router and for responding to ARP requests. The master router sends out periodic advertisements that let backup routers on the network know that it is alive. If the VRRP IP address owner is identified, it always becomes the master router.
master VLAN	In ESRP, the master VLAN is the VLAN on the ESRP domain that exchanges ESRP-PDUs and data between a pair of ESRP-enabled devices. You must configure one master VLAN for each ESRP domain, and a master VLAN can belong to only one ESRP domain.
MED	Multiple exit discriminator. BGP uses the MED metric to select a particular border router in another AS when multiple border routers exist.
MEP	In CFM, maintenance end point is an end point for a single domain, or maintenance association. The MEP may be either an UP MEP or a DOWN MEP.

M (Continued)

metering	In QoS, metering monitors the traffic pattern of each flow against the traffic profile. For out-of-profile traffic the metering function interacts with other components to either re-mark or drop the traffic for that flow. In the Extreme Networks implementation, you use ACLs to enforce metering.
member VLAN	In ESRP, you configure zero or more member VLANs for each ESRP domain. A member VLAN can belong to only one ESRP domain. The state of the ESRP device determines whether the member VLAN is in forwarding or blocking state.
MIB	Management Information Base. MIBs make up a database of information (for example, traffic statistics and port settings) that the switch makes available to network management systems. MIB names identify objects that can be managed in a network and contain information about the objects. MIBs provide a means to configure a network device and obtain network statistics gathered by the device. Standard, minimal MIBs have been defined, and vendors often have private enterprise MIBs.
MIP	In CFM, the maintenance intermediate point is intermediate between endpoints. Each MIP is associated with a single domain, and there may be more than one MIP in a single domain.
mirroring	Port mirroring configures the switch to copy all traffic associated with one or more ports to a designated monitor port. The monitor port can be connected to a network analyzer or RMON probe for packet analyzer.
MM	Management Module.
MMF	Multimode fiber. MMF is a fiber optic cable with a diameter larger than the optical wavelength, in which more than one bound mode can propagate. Capable of sending multiple transmissions simultaneously, MMF is commonly used for communications of 2 kilometers or less.
MSM	Master Switch Fabric Module. This Extreme Networks-proprietary name refers to the module that holds both the control plane and the switch fabric for switches that run the ExtremeXOS software on modular switches. One MSM is required for switch operation; adding an additional MSM increases reliability and throughput. Each MSM has two CPUs. The MSM has LEDs as well as a console port, management port, modem port, and compact flash; it may have data ports as well. The MSM is responsible for upper-layer protocol processing and system management functions. When you save the switch configuration, it is saved to all MSMs.
MSDP	Multicast Source Discovery Protocol. MSDP is used to connect multiple multicast routing domains. MSDP advertises multicast sources across Protocol Independent Multicast-Sparse Mode (PIM-SM) multicast domains or Rendezvous Points (RPs). In turn, these RPs run MSDP over TCP to discover multicast sources in other domains.

M (Continued)

MSTI	Multiple Spanning Tree Instances. MSTIs control the topology inside an MSTP region. An MSTI is a spanning tree domain that operates within a region and is bounded by that region; and MSTI does not exchange BPDUs or send notifications to other regions. You can map multiple VLANs to an MSTI; however, each VLAN can belong to only one MSTI. You can configure up to 64 MSTIs in an MSTP region.
MSTI regional root bridge	In an MSTP environment, each MSTI independently elects its own root bridge. The bridge with the lowest bridge ID becomes the MSTI regional root bridge. The bridge ID includes the bridge priority and the MAC address.
MSTI root port	In an MSTP environment, the port on the bridge with the lowest path cost to the MSTI regional root bridge is the MSTI root port.
MSTP	Multiple Spanning Tree Protocol. MSTP, based on IEEE 802.1Q-2003 (formerly known as IEEE 892.1s), allows you to bundle multiple VLANs into one spanning tree (STP) topology, which also provides enhanced loop protection and better scaling. MSTP uses RSTP as the converging algorithm and is compatible with legacy STP protocols.
MSTP region	An MSTP region defines the logical boundary of the network. Interconnected bridges that have the same MSTP configuration are referred to as an MSTP region. Each MSTP region has a unique identifier, is bound together by one CIST that spans the entire network, and contains from 0 to 64 MSTIs. A bridge participates in only one MSTP region at one time. An MSTP topology is individual MSTP regions connected either to the rest of the network with 802.1D and 802.1w bridges or to each other.
MTU	Maximum transmission unit. This term is a configurable parameter that determines the largest packet that can be transmitted by an IP interface (without the packet needing to be broken down into smaller units). Note: Packets that are larger than the configured MTU size are dropped at the ingress port. Or, if configured to do so, the system can fragment the IPv4 packets and reassemble them at the receiving end.
multicast	Multicast messages are transmitted to selected devices that specifically join the multicast group; the addresses are specified in the destination address field. In other words, multicast (point-to-multipoint) is a communication pattern in which a source host sends a message to a group of destination hosts.

M (Continued)

multinetting	IP multinetting assigns multiple logical IP interfaces on the same circuit or physical interface. This allows one bridge domain (VLAN) to have multiple IP networks.
MVR	Multicast VLAN registration. MVR allows a subscriber on a port to subscribe and unsubscribe to a multicast stream on the network-wide multicast VLAN; it allows the single multicast VLAN to be shared in the network while subscribers remain in separate VLANs. MVR provides the ability to continuously send multicast streams in the multicast VLAN, but to isolate the The application from the subscriber VLANs for bandwidth and security reasons. MVR allows a multicast stream received over a Layer 2 VLAN to be forwarded to another VLAN, eliminating the need for a Layer 3 routing protocol; this feature is often used for IPTV applications.

N

NAT	Network Address Translation. This is a network capability that enables a group of computers to dynamically share a single incoming IP address. NAT takes the single incoming IP address and creates a new IP address for each client computer on the network.
netlogin	Network login provides extra security to the network by assigning addresses only to those users who are properly authenticated. You can use web-based, MAC-based, or IEEE 802.1x-based authentication with network login. The two modes of operation are campus mode and ISP mode.
netmask	A netmask is a string of 0s and 1s that mask, or screen out, the network part of an IP address, so that only the host computer part of the address remains.
neutral state/switch	In ESRP, the neutral state is the initial state entered by the switch. In a neutral state, the switch waits for ESRP to initialize and run. A neutral switch does not participate in ESRP elections.
NLRI	Network layer reachability information. In BGP, the system sends routing update messages containing NLRI to describe a route and how to get there. A BGP update message carries one or more NLRI prefixes and the attributes of a route for each NLRI prefix; the route attributes include a BGP next hop gateway address, community values, and other information.
node	<p>In the Extreme Networks implementation, a node is a CPU that runs the management application on the switch. Each MSM on modular switches installed in the chassis is a node.</p> <p>In general networking terms, a node is a device on the network.</p>

N (Continued)

Node Manager	The Node Manager performs the process of node election, which selects the master, or primary, MSM when you have two MSMS installed in the modular chassis. The Node Manager is useful for system redundancy.
NSSA	<p>Not-so-stubby area. In OSPF, NSSA is a stub area, which is connected to only one other area, with additional capabilities:</p> <ul style="list-style-type: none">● External routes originating from an ASBR connected to the NSSA can be advertised within the NSSA.● External routes originating from the NSSA can be propagated to other areas.

O

odometer	<p>In the Extreme Networks implementation, each field replaceable component contains a system odometer counter in EEPROM.</p> <p>On modular switches, using the CLI, you can display how long each following individual component has been in service:</p> <ul style="list-style-type: none">● chassis● MSMs● I/O modules● power controllers <p>On stand-alone switches, you display the days of service for the switch.</p>
option 82	This is a security feature that you configure as part of BOOTP/DHCP. Option 82 allows a server to bind the client's port, IP address, and MAC number for subscriber identification.
OSI	Open Systems Interconnection. OSI is the international standard computer network architecture known for its 7-layer reference model.
OSI reference model	The 7-layer standard model for network architecture is the basis for defining network protocol standards and the way that data passes through the network. Each layer specifies particular network functions; the highest layer is closest to the user, and the lowest layer is closest to the media carrying the information. So, in a given message between users, there will be a flow of data through each layer at one end down through the layers in that computer and, at the other end, when the message arrives, another flow of data up through the layers in the receiving computer and ultimately to the end user or program. This model is used worldwide for teaching and implementing networking protocols.

O (Continued)

OSPF	Open Shortest Path First. This is an IGP. OSPF, a routing protocol for TCP/IP networks, uses a link state routing algorithm that calculates routes for packets based on a number of factors, including least hops, speed of transmission lines, and congestion delays. You can also configure certain cost metrics for the algorithm. This protocol is more efficient and scalable than vector-distance routing protocols. OSPF features include least-cost routing, ECMP routing, and load balancing. Although OSPF requires CPU power and memory space, it results in smaller, less frequent router table updates throughout the network. This protocol is more efficient and scalable than vector-distance routing protocols.
OSPFv3	OSPFv3 is one of the routing protocols used with IPV6 and is similar to OSPF.
OUI	The Organizational Unique Identifier is the first 24 bits of a MAC address for a network device that indicate a specific vendor as assigned by IEEE.

P

packet	This is the unit of data sent across a network. Packet is a generic term used to describe units of data at all levels of the protocol stack, but it is most correctly used to describe application data units. The packet is a group of bits, including data and control signals, arranged in a specific format. It usually includes a header, with source and destination data, and user data. The specific structure of the packet depends on the protocol used.
partner node	In EAPS, the partner node is that end of the common link that is <i>not</i> a controller node; the partner node does not participate in any form of blocking.
PD	Powered device. In PoE, the PD is the powered device that plugs into the PoE switch.
PDU	Protocol data unit. A PDU is a message of a given protocol comprising payload and protocol-specific control information, typically contained in a header.
PEC	Power Entry Circuit.
PEM	Power Entry Module.
PIM-DM	Protocol-Independent Multicast - Dense mode. PIM-DM is a multicast protocol that uses Reverse Path Forwarding but does not require any particular unicast protocol. It is used when recipients are in a concentrated area.
PIM-SM	Protocol-Independent Multicast - Sparse mode. PIM-SM is a multicast protocol that defines a rendezvous point common to both sender and receiver. Sender and receiver initiate communication at the rendezvous point, and the flow begins over an optimized path. It is used when recipients are in a sparse area.

P (Continued)

ping	Packet Internet Groper. Ping is the ICMP echo message and its reply that tests network reachability of a device. Ping sends an echo packet to the specified host, waits for a response, and reports success or failure and statistics about its operation.
PMBR	PIM multicast border router. A PMBR integrates PIM-DM and PIM-SM traffic.
PoE	Power over Ethernet. The PoE standard (IEEE 802.3af) defines how power can be provided to network devices over existing Ethernet connections.
policy files	You use policy files in ExtremeXOS to specify ACLs and policies. A policy file is a text file (with a <i>.pol</i> extension) that specifies a number of conditions to test and actions to take. For ACLs, this information is applied to incoming traffic at the hardware level. Policies are more general and can be applied to incoming routing information; they can be used to rewrite and modify routing advertisements.
port mirroring	Port mirroring configures the switch to copy all traffic associated with one or more ports to a designated monitor port. A packet bound for or heading away from the mirrored port is forwarded onto the monitor port as well. The monitor port can be connected to a network analyzer or RMON probe for packet analysis. Port mirroring is a method of monitoring network traffic that a network administrator uses as a diagnostic tool or debugging feature; it can be managed locally or remotely.
POST	Power On Self Test. On Extreme Networks switches, the POST runs upon powering-up the device. If the MGMT LED is yellow after the POST completes, contact your supplier for advice.
primary port	In EAPS, a primary port is a port on the master node that is designated the primary port to the ring.
protected VLAN	<p>In STP, protected VLANs are the other (other than the carrier VLAN) VLANs that are members of the STPD but do not define the scope of the STPD. Protected VLANs do not transmit or receive STP BPDUs, but they are affected by STP state changes and inherit the state of the carrier VLAN. Also known as non-carrier VLANs, they carry the data traffic.</p> <p>In EAPS, a protected VLAN is a VLAN that carries data traffic through an EAPS domain. You must configure one or more protected VLANs for each EAPS domain. This is also known as a data VLAN.</p>
proxy ARP	This is the technique in which one machine, usually a router, answers ARP requests intended for another machine. By masquerading its identity (as an endstation), the router accepts responsibility for routing packets to the real destination. Proxy ARP allows a site to use a single IP address with two physical networks. Subnetting is normally a better solution.

P (Continued)

PVST+ Per VLAN Spanning Tree +. This implementation of STP has a 1:1 relationship with VLANs. The Extreme Networks implementation of PVST+ allows you to interoperate with third-party devices running this version of STP. PVST is an earlier version of this protocol and is compatible with PVST+.

Q

QoS Quality of Service. Policy-enabled QoS is a network service that provides the ability to prioritize different types of traffic and to manage bandwidth over a network. QoS uses various methods to prioritize traffic, including IEEE 802.1p values and IP DiffServ values.

R

RADIUS Remote Authentication Dial In User Service. RADIUS is a client/server protocol and software that enables remote access servers to communicate with a central server to authenticate dial-in users and authorize their access to the requested system or service. RADIUS allows a company to maintain user profiles in a central database that all remote servers can share. It provides better security, allowing a company to set up a policy that can be applied at a single administered network point. With RADIUS, you can track usage for billing and for keeping network statistics.

RARP Reverse ARP. Using this protocol, a physical device requests to learn its IP address from a gateway server's ARP table. When a new device is set up, its RARP client program requests its IP address from the RARP server on the router. Assuming that an entry has been set up in the router table, the RARP server will return the IP address to the machine which can store it for future use.

RFC Request for Comment. The IETF RFCs describe the definitions and parameters for networking.

Ridgeline Ridgeline is an Extreme Networks-proprietary graphical user interface (GUI) network management system. The name was changed from EPICenter to Ridgeline in 2011.

RIP Routing Information Protocol. This IGP vector-distance routing protocol is part of the TCP/IP suite and maintains tables of all known destinations and the number of hops required to reach each. Using RIP, routers periodically exchange entire routing tables. RIP is suitable for use only as an IGP.

RIPng RIP next generation. RIPng is one of the routing protocols used with IPV6 and is similar to RIP.

R (Continued)

RMON	Remote monitoring. RMON is a standardized method to make switch and router information available to remote monitoring applications. It is an SNMP network management protocol that allows network information to be gathered remotely. RMON collects statistics and enables a management station to monitor network devices from a central location. It provides multivendor interoperability between monitoring devices and management stations. RMON is described in several RFCs (among them IETF RFC 1757 and RFC 2201). Network administrators use RMON to monitor, analyze, and troubleshoot the network. A software agent can gather the information for presentation to the network administrator with a graphical user interface (GUI). The administrator can find out how much bandwidth each user is using and what Web sites are being accessed; you can also set alarms to be informed of potential network problems.
root bridge	In STP, the root bridge is the bridge with the best bridge identifier selected to be the root bridge. The network has only one root bridge. The root bridge is the only bridge in the network that does not have a root port.
root port	In STP, the root port provides the shortest path to the root bridge. All bridges except the root bridge contain one root port.
route aggregation	In BGP, you can combine the characteristics of several routes so they are advertised as a single route, which reduces the size of the routing tables.
route flapping	A route is flapping when it is repeatedly available, then unavailable, then available, then unavailable. In the ExtremeXOS BGP implementation, you can minimize the route flapping using the route flap dampening feature.
route reflector	In BGP, you can configure the routers within an AS such that a single router serves as a central routing point for the entire AS.
routing confederation	In BGP, you can configure a fully meshed AS into several sub-ASs and group these sub-ASs into a routing confederation. Routing confederations help with the scalability of BGP.
RSTP	Rapid Spanning Tree Protocol. RSTP, described in IEEE 802.1w, is an enhanced version of STP that provides faster convergence. The Extreme Networks implementation of RSTP allows seamless interoperability with legacy STP.

S

SA	Source address. The SA is the IP or MAC address of the device issuing the packet.
SCP	Secure Copy Protocol. SCP2, part of SSH2, is used to transfer configuration and policy files.

S (Continued)

secondary port	In EAPS, the secondary port is a port on the master node that is designated the secondary port to the ring. The transit node ignores the secondary port distinction as long as the node is configured as a transit node.
sFlow	sFlow allows you to monitor network traffic by statistically sampling the network packets and periodically gathering the statistics. The sFlow monitoring system consists of an sFlow agent (embedded in a switch, router, or stand-alone probe) and an external central data collector, or sFlow analyzer.
SFP	Small form-factor pluggable. These transceivers offer high speed and physical compactness.
6in4 tunnels	The 6in4 tunnels, which encapsulate IPv6 packets into IPv4 packets, use dynamic routing protocols to establish connectivity between several IPv6 networks through over the intervening IPv4 network. The 6in4 tunnel must be created at each tunnel endpoint. The IPv6 routing protocol considers the 6in4 tunnel as a single IPv6 hop, even if the tunnel comprises many IPv4 hops; the IPv6 protocol considers the 6in4 tunnel as a normal IPv6 point-to-point link. You can have many 6in4 tunnels per VR.
6to4 tunnels	The 6to4 tunnels are one way to send IPv6 packets over IPv4 networks. This transition mechanism provides a way to connect IPv6 end-site networks by automatically tunnelling over the intervening IPv4 Internet. A special IPv6 routing prefix is used to indicate that the remaining part of the external routing prefix contains the IPv4 endpoint address of a boundary IPv6 router for that site that will process IPv6-in-IPv4-encapsulated packets. You can have only one 6to4 tunnel per VR.
slow path	This term refers to the data path for packets that must be processed by the switch CPU, whether these packets are generated by the CPU, removed from the network by the CPU, or simply forwarded by the CPU.
SMF	Single-mode fiber. SMF is a laser-driven optical fiber with a core diameter small enough to limit transmission to a single bound mode. SMF is commonly used in long distance transmission of more than 3 miles; it sends one transmission at a time.
SMON	Switch Network Monitoring Management (MIB) system defined by the IETF document RFC 2613. SMON is a set of MIB extensions for RMON that allows monitoring of switching equipment from a SNMP Manager in greater detail.
SNMP	Simple Network Management Protocol. SNMP is a standard that uses a common software agent to remotely monitor and set network configuration and runtime parameters. SNMP operates in a multivendor environment, and the agent uses MIBs, which define what information is available from any manageable network device. You can also set traps using SNMP, which send notifications of network events to the system log.

S (Continued)

SNTP	Simple Network Time Protocol. SNTP is used to synchronize the system clocks throughout the network. An extension of the Network Time Protocol, SNTP can usually operate with a single server and allows for IPv6 addressing.
SSH	Secure Shell, sometimes known as Secure Socket Shell, is a UNIX-based command interface and protocol of securely gaining access to a remote computer. With SSH commands, both ends of the client/server connection are authenticated using a digital certificate, and passwords are protected by being encrypted. At Extreme Networks, the SSH is a separate software module, which must be downloaded separately. (SSH is bundled with SSL in the software module.)
SSL	Secure Sockets Layer. SSL is a protocol for transmitting private documents using the Internet. SSL works by using a public key to encrypt data that is transferred over the SSL connection. SSL uses the public-and-private key encryption system, which includes the use of a digital certificate. At Extreme Networks, SSL is bundled with the SSH software module, which must be downloaded separately. SSL used for other applications than SSH, CNA at Extreme Networks for example.
standard mode	Use ESRP standard mode if your network contains switches running ExtremeWare and switches running ExtremeXOS, both participating in ESRP.
STP	Spanning Tree Protocol. STP is a protocol, defined in IEEE 802.1d, used to eliminate redundant data paths and to increase network efficiency. STP allows a network to have a topology that contains physical loops; it operates in bridges and switches. STP opens certain paths to create a tree topology, thereby preventing packets from looping endlessly on the network. To establish path redundancy, STP creates a tree that spans all of the switches in an extended network, forcing redundant paths into a standby, or blocked, state. STP allows only one active path at a time between any two network devices (this prevents the loops) but establishes the redundant links as a backup if the initial link should fail. If STP costs change, or if one network segment in the STP becomes unreachable, the spanning tree algorithm reconfigures the STP topology and re-establishes the link by activating the standby path.
STPD	Spanning Tree Domain. An STPD is an STP instance that contains one or more VLANs. The switch can run multiple STPDs, and each STPD has its own root bridge and active path. In the Extreme Networks implementation of STPD, each domain has a carrier VLAN (for carrying STP information) and one or more protected VLANs (for carrying the data).
STPD mode	The mode of operation for the STPD. The two modes of operation are: <ul style="list-style-type: none">● 802.1d—Compatible with legacy STP and other devices using the IEEE 802.1d standard.● 802.1w—Compatible with Rapid Spanning Tree (RSTP).

S (Continued)

stub areas	In OSPF, a stub area is connected to only one other area (which can be the backbone area). External route information is not distributed to stub areas.
superloop	In EAPS, a superloop occurs if the common link between two EAPS domains goes down and the master nodes of both domains enter the failed state putting their respective secondary ports into the forwarding state. If there is a data VLAN spanning both EAPS domains, this action forms a loop between the EAPS domains.
system health check	The primary responsibility of the system health checker is to monitor and poll error registers. In addition, the system health checker can be enabled to periodically send diagnostic packets. System health check errors are reported to the syslog.

T

TACACS+	Terminal Access Controller Access Control System. Often run on UNIX systems, the TACAS+ protocol provides access control for routers, network access servers, and other networked computing devices via one or more centralized servers. TACACS+ provides separate authentication, authorization, and accounting services. User passwords are administered in a central database rather than in individual routers, providing easily scalable network security solutions.
tagged VLAN	You identify packets as belonging to the same tagged VLAN by putting a value into the 12-bit (4 octet) VLAN ID field that is part of the IEEE 802.1Q field of the header. Using this 12-bit field, you can configure up to 4096 individual VLAN addresses (usually some are reserved for system VLANs such as management and default VLANs); these tagged VLANs can exist across multiple devices. The tagged VLAN can be associated with both tagged and untagged ports.
TCN	Topology change notification. The TCN is a timer used in RSTP that signals a change in the topology of the network.
TCP	Transmission Control Protocol. Together with Internet Protocol (IP), TCP is one of the core protocols underlying the Internet. The two protocols are usually referred to as a group, by the term TCP/IP. TCP provides a reliable connection, which means that each end of the session is guaranteed to receive all of the data transmitted by the other end of the connection, in the same order that it was originally transmitted without receiving duplicates.
TFTP	Trivial File Transfer Protocol. TFTP is an Internet utility used to transfer files, which does not provide security or directory listing. It relies on UDP.
transit node	In EAPS, the transit node is a switch, or node, that is not designated a master in the EAPS domain ring.
TRILL	Transparent Interconnection of Lots of Links.

U

UDP	User Datagram Protocol. This is an efficient but unreliable, connectionless protocol that is layered over IP (as is TCP). Application programs must supplement the protocol to provide error processing and retransmitting data. UDP is an OSI Layer 4 protocol.
unicast	A unicast packet is communication between a single sender and a single receiver over a network.
untagged VLAN	A VLAN remains untagged unless you specifically configure the IEEE 802.1Q value on the packet. A port cannot belong to more than one untagged VLAN using the same protocol.
USM	User-based security model. In SNMPv3, USM uses the traditional SNMP concept of user names to associate with security levels to support secure network management.

V

VEPA	Virtual Ethernet Port Aggregator. This is a Virtual Machine (VM) server feature that works with the ExtremeXOS Direct Attach feature to support communications between VMs. For more information, see “Introduction to the Direct Attach Feature” on page 616 .
virtual link	In OSPF, when a new area is introduced that does not have a direct physical attachment to the backbone, a virtual link is used. Virtual links are also used to repair a discontinuous backbone area.
virtual router	<p>In the Extreme Networks implementations, virtual routers allow a single physical switch to be split into multiple virtual routers. Each virtual router has its own IP address and maintains a separate logical forwarding table. Each virtual router also serves as a configuration domain. The identity of the virtual router you are working in currently displays in the prompt line of the CLI. The virtual routers discussed in relation to Extreme Networks switches themselves are <i>not</i> the same as the virtual router in VRRP.</p> <p>In VRRP, the virtual router is identified by a virtual router (VRID) and an IP address. A router running VRRP can participate in one or more virtual routers. The VRRP virtual router spans more than one physical router, which allows multiple routers to provide redundant services to users.</p>
virtual router MAC address	In VRRP, RFC 2338 assigns a static MAC address for the first five octets of the VRRP virtual router. These octets are set to 00-00-5E-00-01. When you configure the VRRP VRID, the last octet of the MAC address is dynamically assigned the VRID number.
VLAN	Virtual LAN. The term VLAN is used to refer to a collection of devices that communicate as if they are on the same physical LAN. Any set of ports (including all ports on the switch) is considered a VLAN. LAN segments are not restricted by the hardware that physically connects them. The segments are defined by flexible user groups you create with the CLI.
VLSM	Variable-length subnet masks. In OSPF, VLSMs provide subnets of different sizes within a single IP block.

V (Continued)

VM	Virtual Machine. A VM is a logical machine that runs on a VM server, which can host multiple VMs.
VMAN	Virtual MAN. In ExtremeXOS software, VMANs are a bi-directional virtual data connection that creates a private path through the public network. One VMAN is completely isolated from other VMANs; the encapsulation allows the VMAN traffic to be switched over Layer 2 infrastructure. You implement VMAN using an additional 892.1Q tag and a configurable EtherType; this feature is also known as Q-in-Q switching.
VPN	Virtual private network. A VPN is a private network that uses the public network (Internet) to connect remote sites and users. The VPN uses virtual connections routed through the Internet from a private network to remote sites or users. There are different kinds of VPNs, which all serve this purpose. VPNs also enhance security.
VoIP	Voice over Internet Protocol is an Internet telephony technique. With VoIP, a voice transmission is cut into multiple packets, takes the most efficient path along the Internet, and is reassembled when it reaches the destination.
VR-Control	This virtual router (VR) is part of the embedded system in Extreme Networks switches. <i>VR-Control</i> is used for internal communications between all the modules and subsystems in the switch. It has no ports, and you cannot assign any ports to it. It also cannot be associated with VLANs or routing protocols. (Referred to as <i>VR-1</i> in earlier ExtremeXOS software versions.)
VR-Default	This VR is part of the embedded system in Extreme Networks switches. <i>VR-Default</i> is the default VR on the system. All data ports in the switch are assigned to this VR by default; you can add and delete ports from this VR. Likewise, <i>VR-Default</i> contains the default VLAN. Although you cannot delete the default VLAN from <i>VR-Default</i> , you can add and delete any user-created VLANs. One instance of each routing protocol is spawned for this VR, and they cannot be deleted. (Referred to as <i>VR-2</i> in earlier ExtremeXOS software versions.)
VRID	In VRRP, the VRID identifies the VRRP virtual router. Each VRRP virtual router is given a unique VRID. All the VRRP routers that participate in the VRRP virtual router are assigned the same VRID.
VR-Mgmt	This VR is part of the embedded system in Extreme Networks switches. <i>VR-Mgmt</i> enables remote management stations to access the switch through Telnet, SSH, or SNMP sessions; and it owns the management port. The management port cannot be deleted from this VR, and no other ports can be added. The <i>Mgmt</i> VLAN is created <i>VR-Mgmt</i> , and it cannot be deleted; you cannot add or delete any other VLANs or any routing protocols to this VR. (Referred to as <i>VR-0</i> in earlier ExtremeXOS software versions.)

V (Continued)

VRRP	Virtual Router Redundancy Protocol. VRRP specifies an election protocol that dynamically assigns responsibility for a virtual router to one of the VRRP routers on a LAN. The VRRP router controlling the IP address(es) associated with a virtual router is called the master router, and forwards packets sent to these IP addresses. The election process provides dynamic failover in the forwarding responsibility should the master router become unavailable. In case the master router fails, the virtual IP address is mapped to a backup router's IP address; this backup becomes the master router. This allows any of the virtual router IP addresses on the LAN to be used as the default first-hop router by end-hosts. The advantage gained from using VRRP is a higher availability default path without requiring configuration of dynamic routing or router discovery protocols on every host. VRRP is defined in RFC 2338.
VRRP router	Any router that is running VRRP. A VRRP router can participate in one or more virtual routers with VRRP; a VRRP router can be a backup router for one or more master routers.

X

XENPAK	Pluggable optics that contain a 10 Gigabit Ethernet module. The XENPAKs conform to the IEEE 802.3ae standard.
XNV	Extreme Network Virtualization. This ExtremeXOS feature enables the software to support VM port movement, port configuration, and inventory on network switches. For more information, see “Introduction to the XNV Feature” on page 614 .