Content

Chapter 1 ACL Configuration

1.1 Introduction to ACL

ACL (Access Control List) is an IP packet filtering mechanism employed in switches, providing network traffic control by granting or denying access the switches, effectively safeguarding the security of networks. The user can lay down a set of rules according to some information specific to packets, each rule describes the action for a packet with certain information matched: “permit” or “deny”. The user can apply such rules to the incoming direction of switch ports, so that data streams in the incoming direction of specified ports must comply with the ACL rules assigned.

1.1.1 Access-list

Access-list is a sequential collection of conditions that corresponds to a specific rule. Each rule consist of filter information and the action when the rule is matched. Information included in a rule is the effective combination of conditions such as source IP, destination IP, IP protocol number and TCP port, UDP port. Access-lists can be categorized by the following criteria:

- Filter information based criterion: IP access-list (layer 3 or higher information), MAC access-list (layer 2 information), and MAC-IP access-list (layer 2 or layer 3 or higher).
- Configuration complexity based criterion: standard and extended, the extended mode allows more specific filtering of information.
- Nomenclature based criterion: numbered and named.

Description of an ACL should cover the above three aspects.

1.1.2 Access-group

When a set of access-lists are created, they can be applied to traffic of incoming direction on all ports. Access-group is the description to the binding of an access-list to the incoming direction on a specific port. When an access-group is created, all packets from in the incoming direction through the port will be compared to the access-list rule to decide whether to permit or deny access.

The current firmware only supports ingress ACL configuration.

1.1.3 Access-list Action and Global Default Action

There are two access-list actions and default actions: “permit” or “deny”. The following rules apply:

- ☞ An access-list can consist of several rules. Filtering of packets compares packet conditions to the rules, from the first rule to the first matched rule; the rest of the rules will not be processed. Global default action applies only to IP packets in the incoming direction on the ports.
- ☞ Global default action applies only when packet flirter is enabled on a port and no ACL is bound to that port, or no binding ACL matches.

1.2 ACL Configuration Task List

ACL Configuration Task Sequence:

1. Configuring access-list
   (1) Configuring a numbered standard IP access-list
   (2) Configuring a numbered extended IP access-list
   (3) Configuring a standard IP access-list based on nomenclature
      a) Create a standard IP access-list based on nomenclature
      b) Specify multiple “permit” or “deny” rule entries
      c) Exit ACL Configuration Mode
   (4) Configuring an extended IP access-list based on nomenclature
      a) Create an extensive IP access-list based on nomenclature
      b) Specify multiple “permit” or “deny” rule entries
      c) Exit ACL Configuration Mode
   (5) Configuring a numbered standard MAC access-list
   (6) Configuring a numbered extended MAC access-list
   (7) Configuring a extended MAC access-list based on nomenclature
      a) Create a extensive MAC access-list based on nomenclature
      b) Specify multiple “permit” or “deny” rule entries
      c) Exit ACL Configuration Mode
   (8) Configuring a numbered extended MAC-IP access-list
   (9) Configuring a extended MAC-IP access-list based on nomenclature
      a) Create a extensive MAC-IP access-list based on nomenclature
      b) Specify multiple “permit” or “deny” rule entries
      c) Exit MAC-IP Configuration Mode

(10) Configuring a numbered standard IPv6 access-list

(11) Configuring a numbered extended IPv6 access-list

(12) Configuring a standard IPv6 access-list based on nomenclature

a) Create a standard IPv6 access-list based on nomenclature

b) Specify multiple permit or deny rule entries

c) Exit ACL Configuration Mode

(13) Configuring an extended IPv6 access-list based on nomenclature.

a) Create an extensive IPv6 access-list based on nomenclature

b) Specify multiple permit or deny rule entries

c) Exit ACL Configuration Mode

2. Configuring the packet filtering function

(1) Enable global packet filtering function

(2) Configure ACL deny preemption function globally (optional)

3. Configuring time range function

(1) Create the name of the time range

(2) Configure periodic time range

(3) Configure absolute time range

4. Bind access-list to an incoming direction of the specified port

5. Clear the filtering information of the specified port

1. Configuring access-list

(1) Configuring a numbered standard IP access-list

Command	Explanation
Global Mode	
access-list <*num*> {deny | permit} {{<*sIpAddr*> <*sMask*>} | any-source | {host-source <*sIpAddr*>}} **no access-list <*num*>**	Creates a numbered standard IP access-list, if the access-list already exists, then a rule will add to the current access-list; the "**no access-list <*num*>**" command deletes a numbered standard IP access-list.

(2) Configuring a numbered extensive IP access-list

Command	Explanation
Global Mode	

access-list <*num*> {deny | permit} icmp {{<*slpAddr*> <*sMask*>} | any-source | {host-source <*slpAddr*>}} {{<*dlpAddr*> <*dMask*>} | any-destination | {host-destination <*dlpAddr*>}} [<*icmp-type*> [<*icmp-code*>]] [precedence <*prec*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates a numbered ICMP extended IP access rule; if the numbered extended access-list of specified number does not exist, then an access-list will be created using this number.
access-list <*num*> {deny | permit} igmp {{<*slpAddr*> <*sMask*>} | any-source | {host-source <*slpAddr*>}} {{<*dlpAddr*> <*dMask*>} | any-destination | {host-destination <*dlpAddr*>}} [<*igmp-type*>] [precedence <*prec*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates a numbered IGMP extended IP access rule; if the numbered extended access-list of specified number does not exist, then an access-list will be created using this number.
access-list <*num*> {deny | permit} tcp {{<*slpAddr*> <*sMask*>} | any-source | {host-source <*slpAddr*>}} [s-port {<*sPort*> | range <*sPortMin*> <*sPortMax*>}] {{<*dlpAddr*> <*dMask*>} | any-destination | {host-destination <*dlpAddr*>}} [d-port {<*dPort*> | range <*dPortMin*> <*dPortMax*>}] [ack+fin+psh+rst+urg+syn] [precedence <*prec*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates a numbered TCP extended IP access rule; if the numbered extended access-list of specified number does not exist, then an access-list will be created using this number.
access-list <*num*> {deny | permit} udp {{<*slpAddr*> <*sMask*>} | any-source | {host-source <*slpAddr*>}} [s-port {<*sPort*> | range <*sPortMin*> <*sPortMax*>}] {{<*dlpAddr*> <*dMask*>} | any-destination | {host-destination <*dlpAddr*>}} [d-port {<*dPort*> | range <*dPortMin*> <*dPortMax*>}] [precedence <*prec*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates a numbered UDP extended IP access rule; if the numbered extended access-list of specified number does not exist, then an access-list will be created using this number.
access-list <*num*> {deny | permit} {eigrp | gre | igrp | ipinip | ip | ospf | <*protocol-num*>} {{<*slpAddr*> <*sMask*>} | any-source | {host-source <*slpAddr*>}} {{<*dlpAddr*> <*dMask*>} | any-destination | {host-destination <*dlpAddr*>}} [precedence <*prec*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates a numbered IP extended IP access rule for other specific IP protocol or all IP protocols; if the numbered extended access-list of specified number does not exist, then an access-list will be created using this number.
no access-list <*num*>	Deletes a numbered extensive IP access-list.

(3) Configuring a standard IP access-list basing on nomenclature

a. Create a name-based standard IP access-list

Command	Explanation
Global Mode	
ip access-list standard <*name*> **no ip access-list standard <*name*>**	Creates a standard IP access-list based on nomenclature; the "**no ip access-list standard <*name*>**" command deletes the name-based standard IP access-list.

b. Specify multiple "permit" or "deny" rules

Command	Explanation
Standard IP ACL Mode	
[no] {deny | permit} {{<*sIpAddr*> <*sMask*>} | any-source | {host-source <*sIpAddr*>}}	Creates a standard name-based IP access rule; the "**no**" form command deletes the name-based standard IP access rule.

c. Exit name-based standard IP ACL configuration mode

Command	Explanation
Standard IP ACL Mode	
exit	Exits name-based standard IP ACL configuration mode.

(4) Configuring an name-based extended IP access-list

a. Create an extended IP access-list basing on nomenclature

Command	Explanation
Global Mode	
ip access-list extended <*name*> **no ip access-list extended <*name*>**	Creates an extended IP access-list basing on nomenclature; the "**no ip access-list extended <name>** " command deletes the name-based extended IP access-list.

b. Specify multiple "permit" or "deny" rules

Command	Explanation
Extended IP ACL Mode	

[no] {deny | permit} icmp {{<*slpAddr*> <*sMask*>} | any-source | {host-source <*slpAddr*>}} {{<*dlpAddr*> <*dMask*>} | any-destination | {host-destination <*dlpAddr*>}} [<*icmp-type*> [<*icmp-code*>]] [precedence <*prec*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates an extended name-based ICMP IP access rule; the no form command deletes this name-based extended IP access rule.
[no] {deny | permit} igmp {{<*slpAddr*> <*sMask*>} | any-source | {host-source <*slpAddr*>}} {{<*dlpAddr*> <*dMask*>} | any-destination | {host-destination <*dlpAddr*>}} [<*igmp-type*>] [precedence <*prec*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates an extended name-based IGMP IP access rule; the no form command deletes this name-based extended IP access rule.
[no] {deny | permit} tcp {{<*slpAddr*> <*sMask*>} | any-source | {host-source <*slpAddr*>}} [s-port {<*sPort*> | range <*sPortMin*> <*sPortMax*>}] {{<*dlpAddr*> <*dMask*>} | any-destination | {host-destination <*dlpAddr*>}} [d-port {<*dPort*> | range <*dPortMin*> <*dPortMax*>}] [ack+fin+psh+rst+urg+syn] [precedence <*prec*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates an extended name-based TCP IP access rule; the no form command deletes this name-based extended IP access rule.
[no] {deny | permit} udp {{<*slpAddr*> <*sMask*>} | any-source | {host-source <*slpAddr*>}} [s-port {<*sPort*> | range <*sPortMin*> <*sPortMax*>}] {{<*dlpAddr*> <*dMask*>} | any-destination | {host-destination <*dlpAddr*>}} [d-port {<*dPort*> | range <*dPortMin*> <*dPortMax*>}] [precedence <*prec*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates an extended name-based UDP IP access rule; the no form command deletes this name-based extended IP access rule.
[no] {deny | permit} {eigrp | gre | igrp | ipinip | ip | ospf | <protocol-num>} {{<*slpAddr*> <*sMask*>} | any-source | {host-source <*slpAddr*>}} {{<*dlpAddr*> <*dMask*>} | any-destination | {host-destination <*dlpAddr*>}} [precedence <*prec*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates an extended name-based IP access rule for other IP protocols; the no form command deletes this name-based extended IP access rule.

c. Exit extended IP ACL configuration mode

Command	Explanation
Extended IP ACL Mode	

exit	Exits extended name-based IP ACL configuration mode.

(5) Configuring a numbered standard MAC access-list

Command	Explanation
Global Mode	
access-list<*num*>{deny|permit}{any-source-mac|{host-source-mac<*host_smac*>}|{<*smac*><*smac-mask*>}} **no access-list <*num*>**	Creates a numbered standard MAC access-list, if the access-list already exists, then a rule will add to the current access-list; the "**no access-list <*num*>**" command deletes a numbered standard MAC access-list.

(6) Creates a numbered MAC extended access-list

Command	Explanation
Global Mode	
access-list<*num*> {deny|permit} {any-source-mac|{host-source-mac<*host_smac*>}|{<*smac*><*smac-mask*>}}{any-destination-mac|{host-destination-mac<*host_dmac*>}|{<*dmac*><*dmac-mask*>}}[{untagged-eth2 | tagged-eth2 | untagged-802-3 | tagged-802-3} [<*offset1*> <*length1*> <value1> [<*offset2*> <*length2*> <value2> [<offset3> <length3> <value3> [<*offset4*> <*length4*> <*value4*>]]]]] **no access-list <*num*>**	Creates a numbered MAC extended access-list, if the access-list already exists, then a rule will add to the current access-list; the "**no access-list <*num*>**" command deletes a numbered MAC extended access-list.

(7) Configuring a extended MAC access-list based on nomenclature

a. Create an extensive MAC access-list based on nomenclature

Command	Explanation
Global Mode	

mac-access-list extended <*name*> **no mac-access-list extended <*name*>**	Creates an extended name-based MAC access rule for other IP protocols; the no form command deletes this name-based extended MAC access rule.

b. Specify multiple "permit" or "deny" rule entries

Command	Explanation
Extended name-based MAC access rule Mode	
[no]{deny|permit}{any-source-mac|{host-source-mac<*host_smac*>}|{<*smac*><*smac-mask*>}} {any-destination-mac|{host-destination-mac <*host_dmac*>} |{<*dmac*> <*dmac-mask*>}} [cos <*cos-val*> [<*cos-bitmask*>] [vlanId <*vid-value*> [<*vid-mask*>][ethertype<*protocol*>[<*protocol-mask*>]]]]	
[no]{deny|permit} {any-source-mac|{host-source-mac<*host_smac*>}|{<*smac*><*smac-mask*>}} {any-destination-mac|{host-destination-mac<*host_dmac*>}|{<*dmac*><*dmac-mask*>}} [ethertype <*protocol*> [<*protocol-mask*>]]	Creates an extended name-based MAC access rule matching MAC frame; the no form command deletes this name-based extended MAC access rule.
[no]{deny|permit} {any-source-mac|{host-source-mac<*host_smac*>} |{<*smac*><*smac-mask*>}} {any-destination-mac |{host-destination-mac<*host_dmac*>}|{<*dmac*><*dmac-mask*>}} [vlanid <*vid-value*> [<*vid-mask*>][ethertype <*protocol*> [<*protocol-mask*>]]]	

[no]{deny|permit}{any-source-mac|{host-source-mac<*host_smac*>}|{<*smac*><*smac-mask*>}}{any-destination-mac|{host-destination-mac<*host_dmac*>}|{<*dmac*><*dmac-mask*>}}[untagged-eth2 [ethertype <*protocol*> [protocol-mask]]]	Creates an extended name-based MAC access rule matching untagged ethernet 2 frame; the no form command deletes this name-based extended MAC access rule.
[no]{deny|permit}{any-source-mac|{host-source-mac<*host_smac*>}|{<*smac*><*smac-mask*>}} {any-destination-mac|{host-destination-mac <*host_dmac*>}|{<*dmac*><*dmac-mask*>}} [untagged-802-3]	Creates an name-based extended MAC access rule matching 802.3 frame; the no form command deletes this name-based extended MAC access rule.
[no]{deny|permit}{any-source-mac|{host-source-mac<*host_smac*>}|{<*smac*><*smac-mask*>}}{any-destination-mac|{host-destination-mac<*host_dmac*>}|{<*dmac*><*dmac-mask*>}}[tagged-eth2 [cos <*cos-val*> [<*cos-bitmask*>]] [vlanId <*vid-value*> [<*vid-mask*>]] [ethertype<*protocol*> [<*protocol-mask*>]]]	Creates an name-based extended MAC access rule matching tagged ethernet 2 frame; the no form command deletes this name-based extended MAC access rule.
[no]{deny|permit}{any-source-mac|{host-source-mac <*host_smac*>}|{<*smac*><*smac-mask*>}} {any-destination-mac|{host-destination-mac<*host_dmac*>}|{<*dmac*><*dmac-mask*>}} [tagged-802-3 [cos <*cos-val*> [<*cos-bitmask*>]] [vlanId <*vid-value*> [<*vid-mask*>]]]	Creates an name-based extended MAC access rule matching tagged 802.3 frame; the no form command deletes this name-based extended MAC access rule.

c. Exit ACL Configuration Mode

Command	Explanation
Extended name-based MAC access configure Mode	
exit	Quit the extended name-based MAC access configure mode.

(8) Configuring a numbered extended MAC-IP access-list

Command	Explanation
Global mode	

access-list<*num*>{deny|permit} {any-source-mac| {host-source-mac <*host_smac*>} | {<*smac*> <*smac-mask*>}} {any-destination-mac | {host-destination-mac <*host_dmac*>} | {<*dmac*><*dmac-mask*>}} icmp {{<*source*> <*source-wildcard*>} |any-source| {host-source <*source-host-ip*>}} {{<*destination*> <*destination-wildcard*>} | any-destination | {host-destination <*destination-host-ip*>}} [<*icmp-type*> [<*icmp-code*>]] [precedence <*precedence*>] [tos <*tos*>] [time-range <*time-range-name*>]	Creates a numbered mac-icmp extended mac-ip access rule; if the numbered extended access-list of specified number does not exist, then an access-list will be created using this number.
access-list<*num*>{deny|permit}{any-source-mac| {host-source-mac<*host_smac*>}|{<*smac*><*smac-mask*>}} {any-destination-mac|{host-destination-mac <*host_dmac*>}|{<*dmac*><*dmac-mask*>}}igmp {{<*source*><*source-wildcard*>}|any-source| {host-source<*source-host-ip*>}} {{<*destination*><*destination-wildcard*>}|any-destination| {host-destination<*destination-host-ip*>}} [<*igmp-type*>] [precedence <*precedence*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates a numbered mac-igmp extended mac-ip access rule; if the numbered extended access-list of specified number does not exist, then an access-list will be created using this number.
access-list<num>{deny|permit}{any-source-mac| {host-source-mac<host_smac>}|{<smac><smac-mask>}}{any-destination-mac|{host-destination-mac <host_dmac>}|{<dmac><dmac-mask>}}tcp {{<source><source-wildcard>}|any-source| {host-source<source-host-ip>}} [s-port {<*port1*> | range <*sPortMin*> <*sPortMax*>}] {{<destination><destination-wildcard>}|any-destination| {host-destination <destination-host-ip>}} [d-port {<*port3*> | range <*dPortMin*> <*dPortMax*>}] [ack+fin+psh+rst+urg+syn] [precedence <precedence>] [tos <tos>][time-range<*time-range-name*>]	Creates a numbered mac-ip extended mac-tcp access rule; if the numbered extended access-list of specified number does not exist, then an access-list will be created using this number.
access-list<*num*>{deny|permit}{any-source-mac| {host-source-mac<*host_smac*>}|{<*smac*><*smac-*	Creates a numbered mac-udp extended mac-ip

***mask*>}}{any-destination-mac|{host-destination-mac <*host_dmac*>}|{<*dmac*><*dmac-mask*>}}udp {{<*source*><*source-wildcard*>}|any-source| {host-source<*source-host-ip*>}} [s-port {<*port1*> | range <*sPortMin*> <*sPortMax*>}] {{<*destination*><*destination-wildcard*>}|any-destination| {host-destination<*destination-host-ip*>}} [d-port {<*port3*> | range <*dPortMin*> <*dPortMax*>}] [precedence <*precedence*>] [tos <*tos*>][time-range<*time-range-name*>]**	access rule; if the numbered extended access-list of specified number does not exist, then an access-list will be created using this number.
access-list<*num*>{deny|permit}{any-source-mac| {host-source-mac<*host_smac*>}|{<*smac*><*smac-mask*>}} {any-destination-mac|{host-destination-mac <*host_dmac*>}|{<*dmac*><*dmac-mask*>}} {eigrp|gre|igrp|ip|ipinip|ospf|{<*protocol-num*>}} {{<*source*><*source-wildcard*>}|any-source| {host-source<*source-host-ip*>}} {{<*destination*><*destination-wildcard*>}|any-destination| {host-destination<*destination-host-ip*>}} [precedence <*precedence*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates a numbered extended mac-ip access rule for other specific mac-ip protocol or all mac-ip protocols; if the numbered extended access-list of specified number does not exist, then an access-list will be created using this number.
no access-list <*num*>	Deletes this numbered extended MAC-IP access rule.

(9) Configuring a extended MAC-IP access-list based on nomenclature

a. Create an extensive MAC-IP access-list based on nomenclature

Command	Explanation
Global Mode	
mac-ip-access-list extended <*name*> **no mac-ip-access-list extended <*name*>**	Creates an extended name-based MAC-IP access rule; the no form command deletes this name-based extended MAC-IP access rule.

b. Specify multiple “permit” or “deny” rule entries

Command	Explanation
Extended name-based MAC-IP access Mode	
[no]{deny|permit} {any-source-mac|{host-source-mac <*host_smac*>}|{<*smac*><*smac-mask*>}} {any-destination-mac|{host-destination-mac <*host_dmac*>}|{<*dmac*><*dmac-mask*>}}icmp {{<*source*><*source-wildcard*>}|any-source| {host-source<*source-host-ip*>}} {{<*destination*><*destination-wildcard*>}|any-destination| {host-destination <*destination-host-ip*>}} [<*icmp-type*> [<*icmp-code*>]] [precedence <*precedence*>][tos<*tos*>][time-range<*time-range-name*>]	Creates an extended name-based MAC-ICMP access rule; the no form command deletes this name-based extended MAC-ICMP access rule.
[no]{deny|permit}{any-source-mac|{host-source-mac <*host_smac*>}|{<*smac*><*smac-mask*>}} {any-destination-mac|{host-destination-mac <*host_dmac*>}|{<*dmac*><*dmac-mask*>}}igmp {{<*source*><*source-wildcard*>}|any-source| {host-source<*source-host-ip*>}} {{<*destination*><*destination-wildcard*>}|any-destination| {host-destination <*destination-host-ip*>}} [<*igmp-type*>] [precedence <*precedence*>] [tos <*tos*>][time-range<*time-range-name*>]	Creates an extended name-based MAC-IGMP access rule; the no form command deletes this name-based extended MAC-IGMP access rule.
[no]{deny|permit}{any-source-mac|{host-source-mac<host_smac>}|{<smac><smac-mask>}} {any-destination-mac|{host-destination-mac <host_dmac>}|{<dmac><dmac-mask>}}tcp {{<source><source-wildcard>}|any-source| {host-source<source-host-ip>}} [s-port {<*port1*> | range <*sPortMin*> <*sPortMax*>}] {{<destination><destination-wildcard>}|any-destination| {host-destination <destination-host-ip>}} [d-port {<*port3*> | range <*dPortMin*> <*dPortMax*>}] [ack+fin+psh+rst+urg+syn] [precedence<precedence>][tos<tos>][time-range<*time-range-name*>]	Creates an extended name-based MAC-TCP access rule; the no form command deletes this name-based extended MAC-TCP access rule.
[no]{deny|permit}{any-source-mac|{host-source-	Creates an extended

mac<*host_smac*>}|{<*smac*><*smac-mask*>}} {any-destination-mac|{host-destination-mac <*host_dmac*>}|{<*dmac*><*dmac-mask*>}}udp {{<*source*><*source-wildcard*>}|any-source| {host-source<*source-host-ip*>}} [s-port {<*port1*> | range <*sPortMin*> <*sPortMax*>}] {{<*destination*><*destination-wildcard*>}|any-destination| {host-destination <*destination-host-ip*>}} [d-port {<*port3*> | range <*dPortMin*> <*dPortMax*>}] [precedence <*precedence*>] [tos <*tos*>][time-range<*time-range-name*>]	name-based MAC-UDP access rule; the no form command deletes this name-based extended MAC-UDP access rule.
[no]{deny|permit}{any-source-mac|{host-source-mac<*host_smac*>}|{<*smac*><*smac-mask*>}} {any-destination-mac|{host-destination-mac <*host_dmac*>}|{<*dmac*><*dmac-mask*>}} {eigrp|gre|igrp|ip|ipinip|ospf|{<*protocol-num*>}} {{<*source*><*source-wildcard*>}|any-source| {host-source<*source-host-ip*>}} {{<*destination*><*destination-wildcard*>}|any-destination| {host-destination<*destination-host-ip*>}} [precedence<*precedence*>][tos<*tos*>][time-range<*time-range-name*>]	Creates an extended name-based access rule for the other IP protocol; the no form command deletes this name-based extended access rule.

c. Exit MAC-IP Configuration Mode

Command	Explanation
Extended name-based MAC-IP access Mode	
exit	Quit extended name-based MAC-IP access mode.

（10） Configuring a numbered standard IPv6 access-list

Command	Explanation
Global Mode	
ipv6 access-list <*num*> {deny | permit} {{<*sIPv6Addr*> <*sPrefixlen*>} | any-source | {host-source <*sIpv6Addr*>}} **no ipv6 access-list <*num*>**	Creates a numbered standard IPv6 access-list, if the access-list already exists, then a rule will add to the current access-list; the "**no access-list <*num*>**" command deletes a

	numbered standard IPv6 access-list.

（11） Configuring a numbered extensive IPv6 access-list

Command	Explanation
Global Mode	
ipv6 access-list <num-ext> {deny | permit} icmp {{<sIPv6Prefix/sPrefixlen>} | any-source | {host-source <sIPv6Addr>}} {<dIPv6Prefix/dPrefixlen> | any-destination | {host-destination <dIPv6Addr>}} [<icmp-type> [<icmp-code>]] [dscp <dscp>] [flow-label <fl>][time-range<time-range-name>] **ipv6 access-list <num-ext> {deny | permit} tcp {{<sIPv6Prefix/<sPrefixlen>} | any-source | {host-source <sIPv6Addr>}} [s-port {<sPort> | range <sPortMin> <sPortMax>}] {{< dIPv6Prefix/<dPrefixlen>} | any-destination | {host-destination <dIPv6Addr>}} [dPort {<dPort> | range <dPortMin> <dPortMax>}] [syn | ack | urg | rst | fin | psh] [dscp <dscp>] [flow-label <flowlabel>][time-range<time-range-name>]** **ipv6 access-list <num-ext> {deny | permit} udp {{<sIPv6Prefix/<sPrefixlen>} | any-source | {host-source <sIPv6Addr>}} [s-port {<sPort> | range <sPortMin> <sPortMax>}] {{<dIPv6Prefix/<dPrefixlen>} | any-destination | {host-destination <dIPv6Addr>}} [dPort {<dPort> | range <dPortMin> <dPortMax>}] [dscp <dscp>] [flow-label <flowlabel>][time-range<time-range-name>]** **ipv6 access-list <num-ext> {deny | permit} <next-header> {<sIPv6Prefix/sPrefixlen> | any-source | {host-source <sIPv6Addr>}} {<dIPv6Prefix/dPrefixlen> | any-destination | {host-destination <dIPv6Addr>}} [dscp <dscp>] [flow-label <fl>][time-range<time-range-name>]** **no ipv6 access-list <num>**	Creates a numbered extended IPv6 access-list, if the access-list already exists, then a rule will add to the current access-list; the no command deletes a numbered standard IPv6 access-list.

（12）Configuring a standard IPv6 access-list based on nomenclature

a. Create a standard IPv6 access-list based on nomenclature

Command	Explanation
Global Mode	
ipv6 access-list standard <name> **no ipv6 access-list standard <name>**	Creates a standard IP access-list based on nomenclature; the no command delete the name-based standard IPv6 access-list.

b. Specify multiple permit or deny rules

Command	Explanation
Standard IPv6 ACL Mode	
[no] {deny | permit} {{<sIPv6Prefix/sPrefixlen>} | any-source | {host-source <sIPv6Addr> }}	Creates a standard name-based IPv6 access rule; the no form command deletes the name-based standard IPv6 access rule.

c. Exit name-based standard IP ACL configuration mode

Command	Explanation
Standard IPv6 ACL Mode	
exit	Exits name-based standard IPv6 ACL configuration mode.

（13）Configuring an name-based extended IPv6 access-list

a. Create an extended IPv6 access-list basing on nomenclature

Command	Explanation
Global Mode	
ipv6 access-list extended <name> **no ipv6 access-list extended <name>**	Creates an extended IPv6 access-list basing on nomenclature; the no command deletes the name-based extended IPv6 access-list.

b. Specify multiple permit or deny rules

Command	Explanation
Extended IPv6 ACL Mode	
[no] {deny | permit} icmp {{<sIPv6Prefix/sPrefixlen>} |	Creates an extended name-based ICMP IPv6 access rule; the no form command deletes

any-source | {host-source <sIPv6Addr>}} {<dIPv6Prefix/dPrefixlen> | any-destination | {host-destination <dIPv6Addr>}} [<icmp-type> [<icmp-code>]] [dscp <dscp>] [flow-label <flowlabel>] [time-range <time-range-name>]	this name-based extended IPv6 access rule.
[no] {deny | permit} tcp {<sIPv6Prefix/sPrefixlen> | any-source | {host-source <sIPv6Addr>}} [s-port {<sPort> | range <sPortMin> <sPortMax>}] {<dIPv6Prefix/dPrefixlen> | any-destination | {host-destination <dIPv6Addr>}} [d-port {<dPort> | range <dPortMin> <dPortMax>}] [syn | ack | urg | rst | fin | psh] [dscp <dscp>] [flow-label <fl>] [time-range<time-range-name>]	Creates an extended name-based TCP IPv6 access rule; the no form command deletes this name-based extended IPv6 access rule.
[no] {deny | permit} udp {<sIPv6Prefix/sPrefixlen> | any-source | {host-source <sIPv6Addr>}} [s-port {<sPort> | range <sPortMin> <sPortMax>}] {<dIPv6Prefix/dPrefixlen> | any-destination | {host-destination <dIPv6Addr>}} [d-port {<dPort> | range <dPortMin> <dPortMax>}] [dscp <dscp>] [flow-label <fl>] [time-range<time-range-name>]	Creates an extended name-based UDP IPv6 access rule; the no form command deletes this name-based extended IPv6 access rule.
[no] {deny | permit} <proto> {<sIPv6Prefix/sPrefixlen> | any-source | {host-source <sIPv6Addr>}}	Creates an extended name-based IPv6 access rule for other IPv6 protocols; the no form command deletes this name-based extended IPv6 access rule.

{<dIPv6Prefix/dPrefixlen> | any-destination | {host-destination <dIPv6Addr>}} [dscp <dscp>] [flow-label <flowlabel>] [time-range <time-range-name>]	
[no] {deny | permit} {<sIPv6Prefix/sPrefixlen> | any-source | {host-source <sIPv6Addr>}} {<dIPv6Prefix/dPrefixlen> | any-destination | {host-destination <dIPv6Addr>}} [dscp <dscp>] [flow-label <flowlabel>] [time-range <time-range-name>]	Creates an extended name-based IPv6 access rule; the no form command deletes this name-based extended IPv6 access rule.

c. Exit extended IPv6 ACL configuration mode

Command	Explanation
Extended IPv6 ACL Mode	
exit	Exits extended name-based IPv6 ACL configuration mode.

2. Configuring packet filtering function

(1) Enable global packet filtering function

Command	Explanation
Global Mode	
firewall enable	Enables global packet filtering function.
firewall disable	Disables global packet filtering function.

(2) Configure ACL deny preemption function globally

Command	Explanation
Global Mode	
[no] access-list deny-preemption	Enable deny-preemption function, the no command disables deny-preemption function.

3. Configuring time range function

（1）Create the name of the time range

Command	Explanation
Global Mode	
time-range <*time_range_name*>	Create a time range named time_range_name.
no time-range <*time_range_name*>	Stop the time range function named time_range_name.

（2）Configure periodic time range

Command	Explanation
Time range Mode	
absolute-periodic {Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday} <*start_time*> to {Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday} <*end_time*>	Configure the time range for the request of the week, and every week will run by the time range.
periodic {{Monday+Tuesday+Wednesday+Thursday+ Friday+Saturday+Sunday} | daily | weekdays | weekend} <*start_time*> to <*end_time*>	
[no] absolute-periodic {Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday} <*start_time*> to {Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday} <*end_time*>	Stop the function of the time range in the week.
[no] periodic {{Monday+Tuesday+Wednesday+Thursday+ Friday+Saturday+Sunday} | daily | weekdays | weekend} <*start_time*> to <*end_time*>	

（3）Configure absolute time range

Command	Explanation
Global Mode	
absolute start <*start_time*> <*start_data*> [end <*end_time*> <*end_data*>]	Configure absolute time range.
[no] absolute start <*start_time*> <*start_data*> [end <*end_time*> <*end_data*>]	Stop the function of the time range.

4. Bind access-list to a specific direction of the specified port.

Command	Explanation
Physical Port Mode/VLAN Interface Mode	
{ip|ipv6|mac|mac-ip} access-group *<acl-name>* {in|out} [traffic-statistic] **no {ip|ipv6|mac|mac-ip} access-group *<acl-name>* {in|out}**	Apply an access-list to the ingress or egress direction on the port; the no command deletes the access-list bound to the port.

5. Clear the filtering information of the specified port

Command	Explanation
Admin Mode	
clear access-group (in | out) statistic interface { *<interface-name>* | ethernet *<interface-name>* }	Clear the filtering information of the egress or ingress for the specified port.

1.3 ACL Example

Scenario 1:

The user has the following configuration requirement: port 10 of the switch connects to 10.0.0.0/24 segment, ftp is not desired for the user.

Configuration description:

1. Create a proper ACL
2. Configuring packet filtering function
3. Bind the ACL to the port

The configuration steps are listed below:

Switch(config)#access-list 110 deny tcp 10.0.0.0 0.0.0.255 any-destination d-port 21
Switch(config)#firewall enable
Switch(config)#firewall default permit
Switch(config)#interface ethernet 1/0/10
Switch(Config-If-Ethernet1/0/10)#ip access-group 110 in
Switch(Config-If-Ethernet1/0/10)#exit
Switch(config)#exit

Configuration result:

Switch#show firewall
Firewall status: enable.
Firewall Default Rule: Permit.
Switch#show access-lists
access-list 110(used 1 time(s)) 1 rule(s)
access-list 110 deny tcp 10.0.0.0 0.0.0.255 any-destination d-port 21

Switch#show access-group interface ethernet 1/0/10
interface name:Ethernet1/0/10
the ingress acl use in firewall is 110, traffic-statistics Disable.

Scenario 2:

The configuration requirement is stated as below: The switch should drop all the 802.3 datagram with 00-12-11-23-xx-xx as the source MAC address coming from interface 10.

Configuration description:

1. Create the corresponding MAC ACL.
2. Configure datagram filtering.
3. Bind the ACL to the related interface.

The configuration steps are listed as below.

Switch(config)#access-list 1100 deny 00-12-11-23-00-00 00-00-00-00-ff-ff any-destination-mac untagged-802-3
Switch(config)#access-list 1100 deny 00-12-11-23-00-00 00-00-00-00-ff-ff any tagged-802
Switch(config)#firewall enable
Switch(config)#firewall default permit
Switch(config)#interface ethernet1/0/10
Switch(Config-If-Ethernet1/0/10)#mac access-group 1100 in
Switch(Config-If-Ethernet1/0/10)#exit
Switch(config)#exit

Configuration result:

Switch#show firewall
Firewall Status: Enable.
Firewall Default Rule: Permit.

Switch #show access-lists
access-list 1100(used 1 time(s))
access-list 1100 deny 00-12-11-23-00-00 00-00-00-00-ff-ff
any-destination-mac

untagged-802-3

access-list 1100 deny 00-12-11-23-00-00 00-00-00-00-ff-ff any-destination-mac

Switch #show access-group interface ethernet 1/0/10

interface name:Ethernet1/0/10

MAC Ingress access-list used is 1100,traffic-statistics Disable.

Scenario 3:

The configuration requirement is stated as below: The MAC address range of the network connected to the interface 10 of the switch is 00-12-11-23-xx-xx, and IP network is 10.0.0.0/24. FTP should be disabled and ping requests from outside network should be disabled.

Configuration description:

1. Create the corresponding access list.
2. Configure datagram filtering.
3. Bind the ACL to the related interface.

The configuration steps are listed as below.

Switch(config)#access-list 3110 deny 00-12-11-23-00-00 00-00-00-00-ff-ff any-destination-mac tcp 10.0.0.0 0.0.0.255 any-destination d-port 21

Switch(config)#access-list 3110 deny any-source-mac 00-12-11-23-00-00 00-00-00-00-ff-ff icmp any-source 10.0.0.0 0.0.0.255

Switch(config)#firewall enable

Switch(config)#firewall default permit

Switch(config)#interface ethernet 1/0/10

Switch(Config-If-Ethernet1/0/10)#mac-ip access-group 3110 in

Switch(Config-Ethernet1/0/10)#exit

Switch(config)#exit

Configuration result:

Switch#show firewall

Firewall Status: Enable.

Firewall Default Rule: Permit.

Switch#show access-lists

access-list 3110(used 1 time(s))

access-list 3110 deny 00-12-11-23-00-00 00-00-00-00-ff-ff any-destination-mac

tcp 10.0.0.0 0.0.0.255 any-destination d-port 21

access-list 3110 deny any-source-mac 00-12-11-23-00-00 00-00-00-00-ff-ff icmp any-source 10.0.0.0 0.0.0.255

Switch #show access-group interface ethernet 1/0/10
interface name:Ethernet1/0/10
MAC-IP Ingress access-list used is 3110, traffic-statistics Disable.

Scenario 4:

The configuration requirement is stated as below: IPv6 protocol runs on the interface 600 of the switch. And the IPv6 network address is 2003:1:1:1::0/64. Users in the 2003:1:1:1:66::0/80 subnet should be disabled from accessing the outside network.

Configuration description:

1. Create the corresponding access list.
2. Configure datagram filting.
3. Bind the ACL to the related interface.

The configuration steps are listed as below.

Switch(config)#ipv6 access-list 600 permit 2003:1:1:1:66::0/80 any-destination
Switch(config)#ipv6 access-list 600 deny 2003:1:1:1::0/64 any-destination

Switch(config)#firewall enable
Switch(config)#firewall default permit
Switch(config)#interface ethernet 1/0/10
Switch(Config-If-Ethernet1/0/10)#ipv6 access-group 600 in
Switch(Config-If-Ethernet1/0/10)#exit
Switch(config)#exit

Configuration result:

Switch#show firewall
Firewall Status: Enable.
Firewall Default Rule: Permit.

Switch#show ipv6 access-lists
Ipv6 access-list 600(used 1 time(s))
ipv6 access-list 600 deny 2003:1:1:1::0/64 any-source
ipv6 access-list 600 permit 2003:1:1:1:66::0/80 any-source

Switch #show access-group interface ethernet 1/0/10
interface name:Ethernet1/0/10
IPv6 Ingress access-list used is 600, traffic-statistics Disable.

Scenario 5:

The configuration requirement is stated as below: The interface 1, 2, 5, 7 belongs to vlan100, Hosts with 192.168.0.1 as its IP address should be disabled from accessing the listed interfaces.

Configuration description:

1. Create the corresponding access list.
2. Configure datagram filtering.
3. Bind the ACL to the related interface.

The configuration steps are listed as below.

Switch (config)#firewall enable
Switch (config)#vlan 100
Switch (Config-Vlan100)#switchport interface ethernet 1/0/1;2;5;7
Switch (Config-Vlan100)#exit
Switch (config)#access-list 1 deny host-source 192.168.0.1
Switch (config)#interface ethernet1/0/1;2;5;7
Switch (config-if-port-range)#ip access-group 1 in
Switch (Config-if-Vlan100)#exit

Configuration result:

Switch (config)#show access-group interface vlan 100
Interface VLAN 100:
Ethernet1/0/1: IP Ingress access-list used is 1, traffic-statistics Disable.
Ethernet1/0/2: IP Ingress access-list used is 1, traffic-statistics Disable.
Ethernet1/0/5: IP Ingress access-list used is 1, traffic-statistics Disable.
Ethernet1/0/7: IP Ingress access-list used is 1, traffic-statistics Disable.

1.4 ACL Troubleshooting

- Checking for entries in the ACL is done in a top-down order and ends whenever an entry is matched.
- Default rule will be used only if no ACL is bound to the incoming direction of the port, or no ACL entry is matched.Each ingress port can bind one MAC-IP ACL, one IP ACL, one MAC ACL, one IPv6 standard ACL (via the physical interface mode or Vlan interface mode).
- When binding four ACL and packet matching several ACL at the same time, the priority relations are as follows in a top-down order. If the priority is same, then the priority of configuration at first is higher.

- Ingress IPv6 ACL
- Ingress MAC-IP ACL
- Ingress IP ACL
- Ingress MAC ACL

☞ The number of ACLs that can be successfully bound depends on the content of the ACL bound and the hardware resource limit. Users will be prompted if an ACL cannot be bound due to hardware resource limitation.

☞ If an access-list contains same filtering information but conflicting action rules, binding to the port will fail with an error message. For instance, configuring “permit tcp any any-destination” and “deny tcp any any-destination” at the same time is not permitted.

☞ Viruses such as “worm.blaster” can be blocked by configuring ACL to block specific ICMP packets or specific TCP or UDP port packet.

☞ If the physical mode of an interface is TRUNK, ACL can only be configured through physical interface mode.

☞ ACL configured in the physical mode can only be disabled in the physical mode. Those configured in the VLAN interface configuration mode can only be disabled in the VLAN interface mode.

☞ When a physical interface is added into or removed from a VLAN (with the trunk interfaces as exceptions), ACL configured in the corresponding VLAN will be bound or unbound respectively. If ACL configured in the target VLAN, which is configured in VLAN interface mode, conflicts with existing ACL configuration on the interface, which is configured in physical interface mode, the configuration will fail to effect.

☞ When no physical interfaces are configured in the VLAN, the ACL configuration of the VLAN will be removed. And it can not recover if new interfaces are added to the VLAN.

☞ When the interface mode is changed from access mode to trunk mode, the ACL configured in VLAN interface mode which is bound to physical interface will be removed. And when the interface mode is changed from trunk mode to access mode, ACL configured in VLAN1 interface mode will be bound to the physical interface. If binding fails, the changing will fail either.

Chapter 2 802.1x Configuration

2.1 Introduction to 802.1x

The 802.1x protocol originates from 802.11 protocol, the wireless LAN protocol of IEEE, which is designed to provide a solution to doing authentication when users access a wireless LAN. The LAN defined in IEEE 802 LAN protocol does not provide access authentication, which means as long as the users can access a LAN controlling device (such as a LAN Switch), they will be able to get all the devices or resources in the LAN. There was no looming danger in the environment of LAN in those primary enterprise networks.

However, along with the boom of applications like mobile office and service operating networks, the service providers should control and configure the access from user. The prevailing application of WLAN and LAN access in telecommunication networks, in particular, make it necessary to control ports in order to implement the user-level access control. And as a result, IEEE LAN/WAN committee defined a standard, which is 802.1x, to do Port-Based Network Access Control. This standard has been widely used in wireless LAN and ethernet.

“Port-Based Network Access Control” means to authenticate and control the user devices on the level of ports of LAN access devices. Only when the user devices connected to the ports pass the authentication, can they access the resources in the LAN, otherwise, the resources in the LAN won’t be available.

2.1.1 The Authentication Structure of 802.1x

The system using 802.1x has a typical Client/Server structure, which contains three entities (as illustrated in the next figure): Supplicant system, Authenticator system, and Authentication server system.

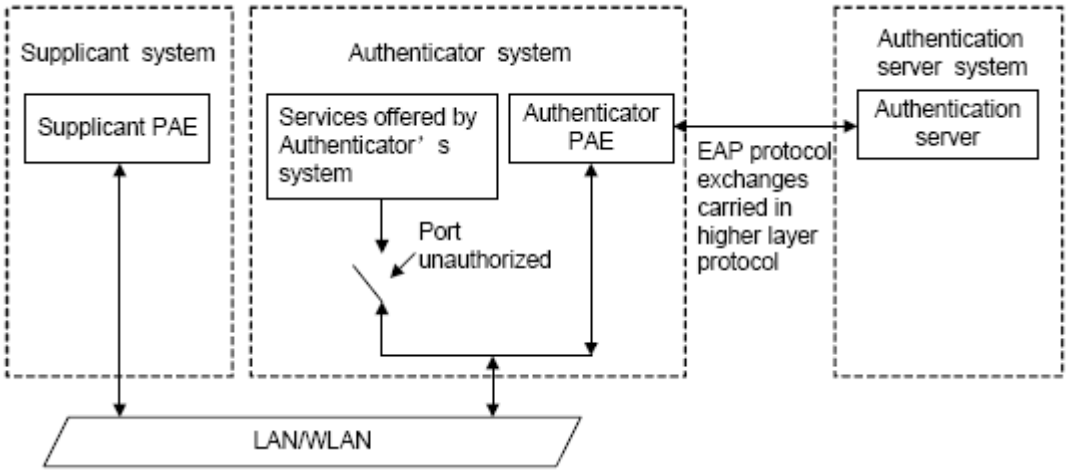


Fig 2-1 The Authentication Structure of 802.1x

- The supplicant system is an entity on one end of the LAN segment, should be authenticated by the access controlling unit on the other end of the link. A Supplicant system usually is a user terminal device. Users start 802.1x authentication by starting supplicant system software. A supplicant system should support EAPOL (Extensible Authentication Protocol over LAN).
- The authenticator system is another entity on one end of the LAN segment to authenticate the supplicant systems connected. An authenticator system usually is a network device supporting 802,1x protocol, providing ports to access the LAN for supplicant systems. The ports provided can either be physical or logical.
- The authentication server system is an entity to provide authentication service for authenticator systems. The authentication server system is used to authenticate and authorize users, as well as does fee-counting, and usually is a RADIUS (Remote Authentication Dial-In User Service) server, which can store the relative user information, including username, password and other parameters such as the VLAN and ports which the user belongs to.

The three entities above concerns the following basic concepts: PAE of the port, the controlled ports and the controlled direction.

1. PAE

PAE (Port Access Entity) is the entity to implement the operation of algorithms and protocols.

- The PAE of the supplicant system is supposed to respond the authentication request from the authenticator systems and submit user's authentication information to the authenticator system. It can also send authentication request and off-line request to authenticator.
- The PAE of the authenticator system authenticates the supplicant systems needing to

access the LAN via the authentication server system, and deal with the authenticated/unauthenticated state of the controlled port according to the result of the authentication. The authenticated state means the user is allowed to access the network resources, the unauthenticated state means only the EAPOL messages are allowed to be received and sent while the user is forbidden to access network resources.

2. controlled/uncontrolled ports

The authenticator system provides ports to access the LAN for the supplicant systems. These ports can be divided into two kinds of logical ports: controlled ports and uncontrolled ports.

- ☞ The uncontrolled port is always in bi-directionally connected status, and mainly used to transmit EAPOL protocol frames, to guarantee that the supplicant systems can always send or receive authentication messages.
- ☞ The controlled port is in connected status authenticated to transmit service messages. When unauthenticated, no message from supplicant systems is allowed to be received.
- ☞ The controlled and uncontrolled ports are two parts of one port, which means each frame reaching this port is visible on both the controlled and uncontrolled ports.

3. Controlled direction

In unauthenticated status, controlled ports can be set as unidirectional controlled or bi-directionally controlled.

- ☞ When the port is bi-directionally controlled, the sending and receiving of all frames is forbidden.
- ☞ When the port is unidirectional controlled, no frames can be received from the supplicant systems while sending frames to the supplicant systems is allowed.

Notes: At present, this kind of switch only supports unidirectional control.

2.1.2 The Work Mechanism of 802.1x

IEEE 802.1x authentication system uses EAP (Extensible Authentication Protocol) to implement exchange of authentication information between the supplicant system, authenticator system and authentication server system.

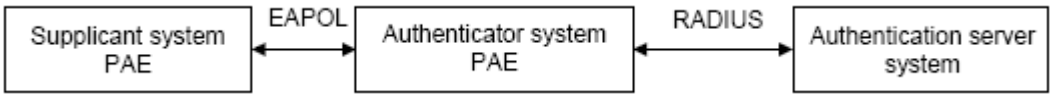


Fig 2-2 the Work Mechanism of 802.1x

- EAP messages adopt EAPOL encapsulation format between the PAE of the supplicant system and the PAE of the authenticator system in the environment of LAN.
- Between the PAE of the authenticator system and the RADIUS server, there are two methods to exchange information: one method is that EAP messages adopt EAPOR (EAP over RADIUS) encapsulation format in RADIUS protocol; the other is that EAP messages terminate with the PAE of the authenticator system, and adopt the messages containing RAP (Password Authentication Protocol) or CHAP (Challenge Handshake Authentication Protocol) attributes to do the authentication interaction with the RADIUS server.
- When the user pass the authentication, the authentication server system will send the relative information of the user to authenticator system, the PAE of the authenticator system will decide the authenticated/unauthenticated status of the controlled port according to the authentication result of the RADIUS server.

2.1.3 The Encapsulation of EAPOL Messages

1. The Format of EAPOL Data Packets

EAPOL is a kind of message encapsulation format defined in 802.1x protocol, and is mainly used to transmit EAP messages between the supplicant system and the authenticator system in order to allow the transmission of EAP messages through the LAN. In IEEE 802/Ethernet LAN environment, the format of EAPOL packet is illustrated in the next figure. The beginning of the EAPOL packet is the Type/Length domain in MAC frames.

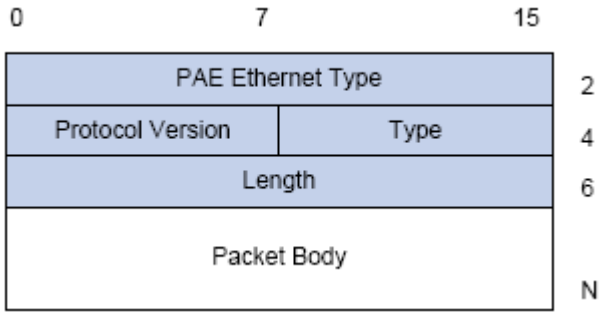


Fig 2-3 the Format of EAPOL Data Packet

PAE Ethernet Type: Represents the type of the protocol whose value is 0x888E.

Protocol Version: Represents the version of the protocol supported by the sender of EAPOL data packets.

Type: represents the type of the EAPOL data packets, including:

- EAP-Packet (whose value is 0x00): the authentication information frame, used to

carry EAP messages. This kind of frame can pass through the authenticator system to transmit EAP messages between the supplicant system and the authentication server system.

- EAPOL-Start (whose value is 0x01): the frame to start authentication.
- EAPOL-Logoff (whose value is 0x02): the frame requesting to quit.
- EAPOL-Key (whose value is 0x03): the key information frame.
- EAPOL-Encapsulated-ASF-Alert (whose value is 0x04): used to support the Alerting messages of ASF (Alert Standard Forum). This kind of frame is used to encapsulate the relative information of network management such as all kinds of alerting information, terminated by terminal devices.

Length: represents the length of the data, that is, the length of the “Packet Body”, in byte. There will be no following data domain when its value is 0.

Packet Body: represents the content of the data, which will be in different formats according to different types.

2. The Format of EAP Data Packets

When the value of Type domain in EAPOL packet is EAP-Packet, the Packet Body is in EAP format (illustrated in the next figure).

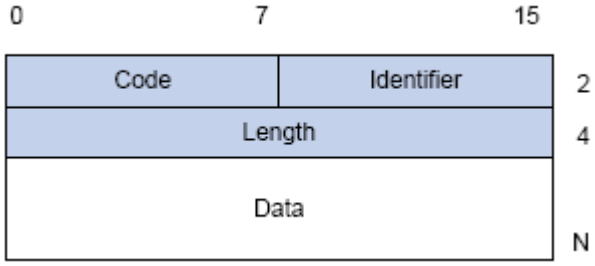


Fig 2-4 the Format of EAP Data Packets

Code: specifies the type of the EAP packet. There are four of them in total: Request（1）,Response（2）,Success（3）,Failure（4）.

- There is no Data domain in the packets of which the type is Success or Failure, and the value of the Length domains in such packets is 4.
- The format of Data domains in the packets of which the type is Request and Response is illustrated in the next figure. Type is the authentication type of EAP, the content of Type data depends on the type. For example, when the value of the type is 1, it means Identity, and is used to query the identity of the other side. When the type is 4, it means MD5-Challenge, like PPP CHAP protocol, contains query messages.

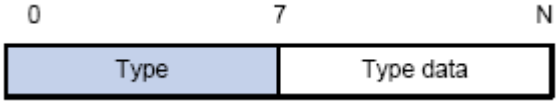


Fig 2-5 the Format of Data Domain in Request and Response Packets

Identifier: to assist matching the Request and Response messages.

Length: the length of the EAP packet, covering the domains of Code, Identifier, Length and Data, in byte.

Data: the content of the EAP packet, depending on the Code type.

2.1.4 The Encapsulation of EAP Attributes

RADIUS adds two attribute to support EAP authentication: EAP-Message and Message-Authenticator. Please refer to the Introduction of RADIUS protocol in “AAA-RADIUS-HWTACACS operation” to check the format of RADIUS messages.

1. EAP-Message

As illustrated in the next figure, this attribute is used to encapsulate EAP packet, the type code is 79, String domain should be no longer than 253 bytes. If the data length in an EAP packet is larger than 253 bytes, the packet can be divided into fragments, which then will be encapsulated in several EAP-Messages attributes in their original order.

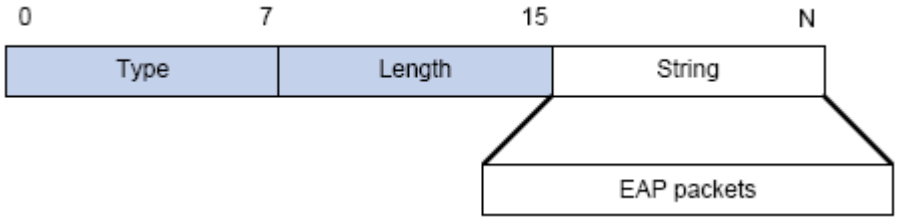


Fig 2-6 the Encapsulation of EAP-Message Attribute

2. Message-Authenticator

As illustrated in the next figure, this attribute is used in the process of using authentication methods like EAP and CHAP to prevent the access request packets from being eavesdropped. Message-Authenticator should be included in the packets containing the EAP-Message attribute, or the packet will be dropped as an invalid one.

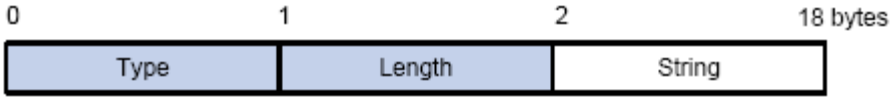


Fig 2-7 Message-Authenticator Attribute

2.1.5 Web Authentication Proxy based on 802.1x

The perspective of prior 802.1x authentication system abided by IEEE 802.1 x authentication systems on architecture, working mechanism, business processes. The client authentication pattern of prior authentication system privately. The devices are layer

2 switch and the authentication server is RADIUS server. EAP protocol is used for the authentication message pattern. EAPOL encapsulation is used between client and the authentication proxy switch, that is to say, EAP message is encapsulated in the Ethernet frame to authenticate and communicate, however, EAPOR encapsulation is used between authentication proxy switch and authentication server, that is to say, EAP message is loaded on the Radius protocol to authenticate and communicate. it can be also forward by the device, transmit the PAP protocol message or CHAP protocol message based on the RADIUS protocol between the device and the RADIUS sever.

In 802.1x authentication system, in order to implement the identity authentication and the network permission, user should install the authentication client software, pass client login authentication progress and then achieve authenticated communication with DCBI server. But some customers do not want to install client software, and they hope to authenticate by the internet explorer simplified. So in order to satisfy the new demand from the user and realize the platforms irrelevance of the authentication client, the Web authentication function based on 802.1x is designed for authentication.

The Web authentication is still based on IEEE 802.1x authentication system, the Java Applet in internet explorer is instead of the prior client software, the devises is layer 3 switch, authentication server is the standardized RADIUS server, and the authentication message is loaded in the EAP message to communicate. The Ethernet frame can't be send because of the Java Applet used in client, so EAP message can't be encapsulated in the Ethernet frame to send, EAP message should be loaded on the UDP protocol instead of EAPOU, in order to achieve the authentication and communication between web client and web authentication proxy switch. The standardized EAPOR protocol is still used between the authentication proxy switch and authentication server.

2.1.6 The Authentication Methods of 802.1x

The authentication can either be started by supplicant system initiatively or by devices. When the device detects unauthenticated users to access the network, it will send supplicant system EAP-Request/Identity messages to start authentication. On the other hand, the supplicant system can send EAPOL-Start message to the device via supplicant software.

802.1 x systems supports EAP relay method and EAP termination method to implement authentication with the remote RADIUS server. The following is the description of the process of these two authentication methods, both started by the supplicant system.

2.1.6.1 EAP Relay Mode

EAP relay is specified in IEEE 802.1x standard to carry EAP in other high-level

protocols, such as EAP over RADIUS, making sure that extended authentication protocol messages can reach the authentication server through complicated networks. In general, EAP relay requires the RADIUS server to support EAP attributes: EAP-Message and Message-Authenticator.

EAP is a widely-used authentication frame to transmit the actual authentication protocol rather than a special authentication mechanism. EAP provides some common function and allows the authentication mechanisms expected in the negotiation, which are called EAP Method. The advantage of EAP lies in that EAP mechanism working as a base needs no adjustment when a new authentication protocol appears. The following figure illustrates the protocol stack of EAP authentication method.

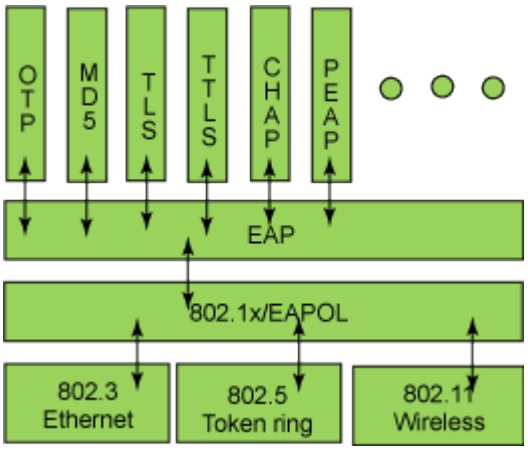


Fig 2-8 the Protocol Stack of EAP Authentication Method

By now, there are more than 50 EAP authentication methods has been developed, the differences among which are those in the authentication mechanism and the management of keys. The 4 most common EAP authentication methods are listed as follows:

- **EAP-MD5**
- **EAP-TLS**（Transport Layer Security）
- **EAP-TTLS**（Tunneled Transport Layer Security）
- **PEAP**（Protected Extensible Authentication Protocol）

They will be described in detail in the following part.

Attention:

- The switch, as the access controlling unit of Pass-through, will not check the content of a particular EAP method, so can support all the EAP methods above and all the EAP authentication methods that may be extended in the future.
- In EAP relay, if any authentication method in EAP-MD5, EAP-TLS, EAP-TTLS and PEAP is adopted, the authentication methods of the supplicant system and the RADIUS server should be the same.

1. EAP-MD5 Authentication Method

EAP-MD5 is an IETF open standard which providing the least security, since MD5 Hash function is vulnerable to dictionary attacks.

The following figure illustrated the basic operation flow of the EAP-MD5 authentication method.

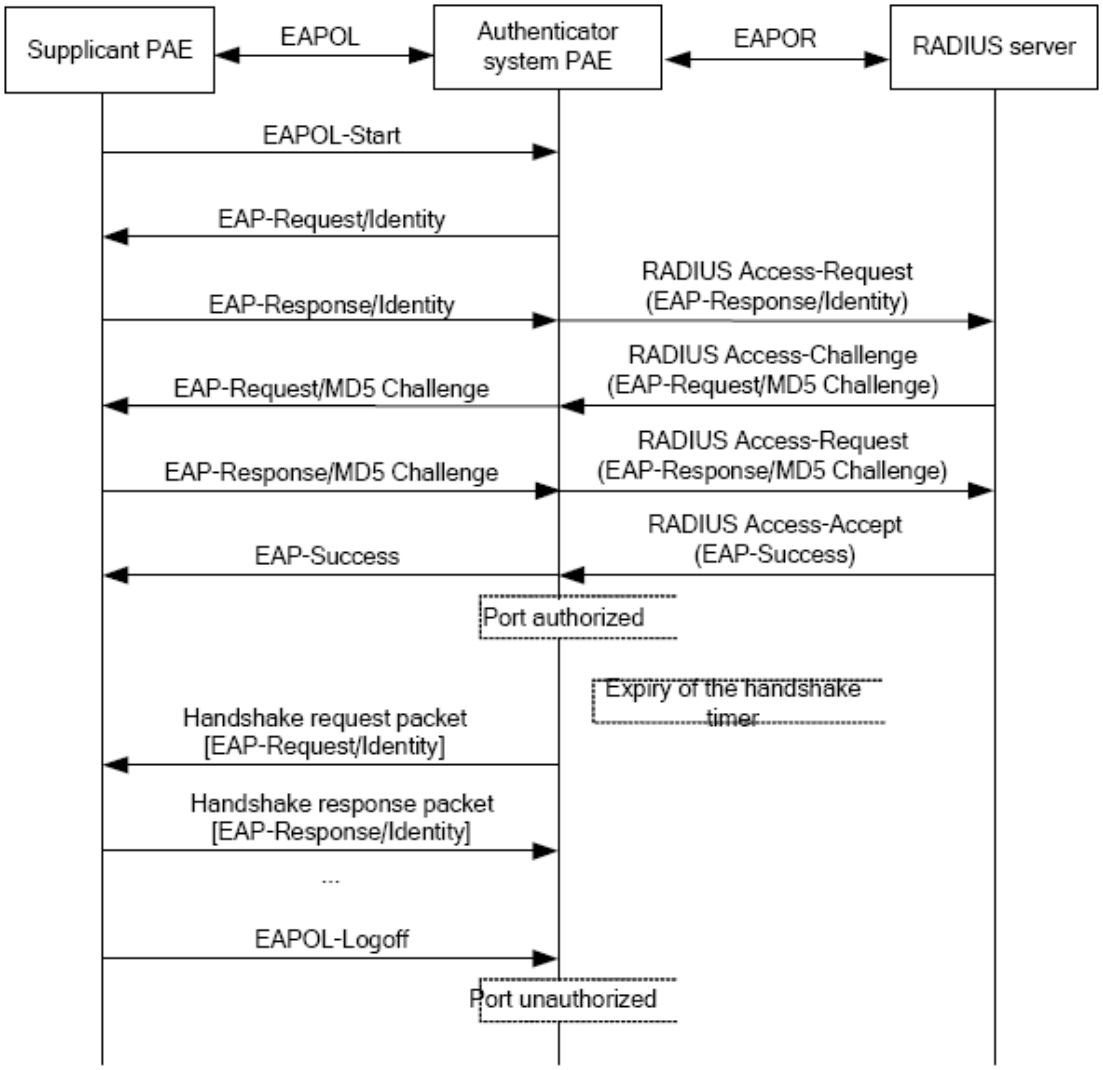


Fig 2-9 the Authentication Flow of 802.1x EAP-MD5

2. EAP-TLS Authentication Method

EAP-TLS is brought up by Microsoft based on EAP and TLS protocols. It uses PKI to protect the id authentication between the supplicant system and the RADIUS server and the dynamically generated session keys, requiring both the supplicant system and the Radius authentication server to possess digital certificate to implement bidirectional authentication. It is the earliest EAP authentication method used in wireless LAN. Since every user should have a digital certificate, this method is rarely used practically considering the difficult maintenance. However it is still one of the safest EAP standards,

and enjoys prevailing supports from the vendors of wireless LAN hardware and software.

The following figure illustrates the basic operation flow of the EAP-TLS authentication method.

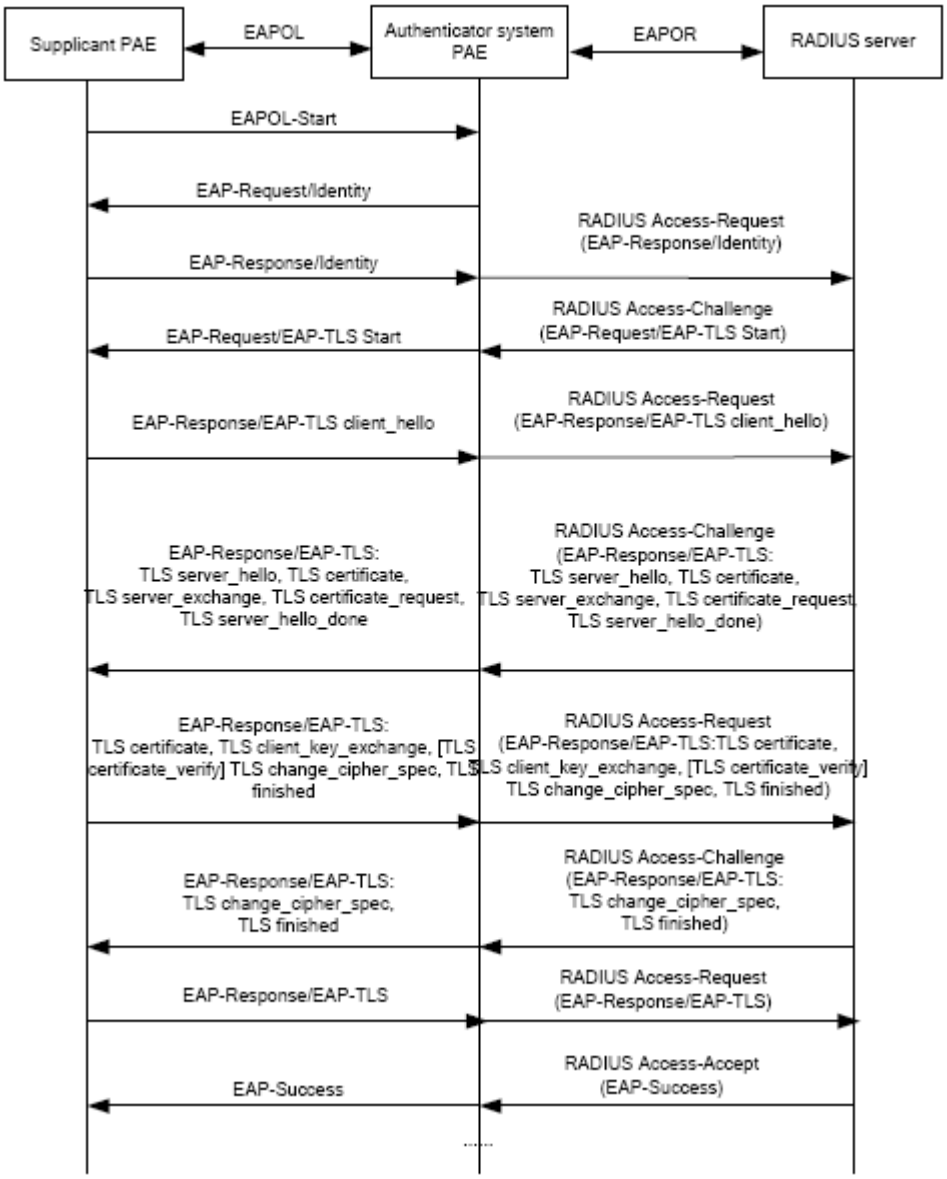


Fig 2-10 the Authentication Flow of 802.1x EAP-TLS

3. EAP-TTLS Authentication Method

EAP-TTLS is a product of the cooperation of Funk Software and Certicom. It can provide an authentication as strong as that provided by EAP-TLS, but without requiring users to have their own digital certificate. The only request is that the Radius server should have a digital certificate. The authentication of users' identity is implemented with passwords transmitted in a safely encrypted tunnel established via the certificate of the authentication server. Any kind of authentication request including EAP, PAP and

MS-CHAPV2 can be transmitted within TTLS tunnels.

4. PEAP Authentication Method

EAP-PEAP is brought up by Cisco, Microsoft and RAS Security as a recommended open standard. It has long been utilized in products and provides very good security. Its design of protocol and security is similar to that of EAP-TTLS, using a server's PKI certificate to establish a safe TLS tunnel in order to protect user authentication.

The following figure illustrates the basic operation flow of PEAP authentication method.

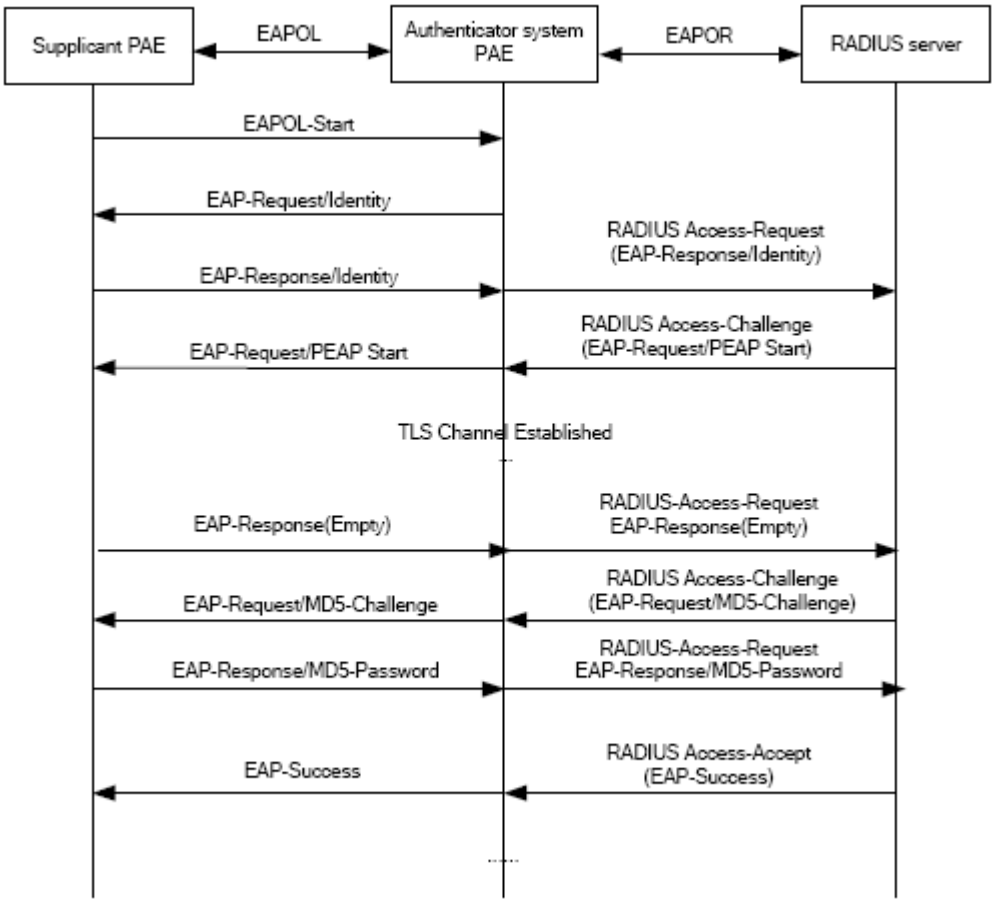


Fig 2-11 the Authentication Flow of 802.1x PEAP

2.1.6.2 EAP Termination Mode

In this mode, EAP messages will be terminated in the access control unit and mapped into RADIUS messages, which is used to implement the authentication, authorization and fee-counting. The basic operation flow is illustrated in the next figure.

In EAP termination mode, the access control unit and the RADIUS server can use PAP or CHAP authentication method. The following figure will demonstrate the basic

operation flow using CHAP authentication method.

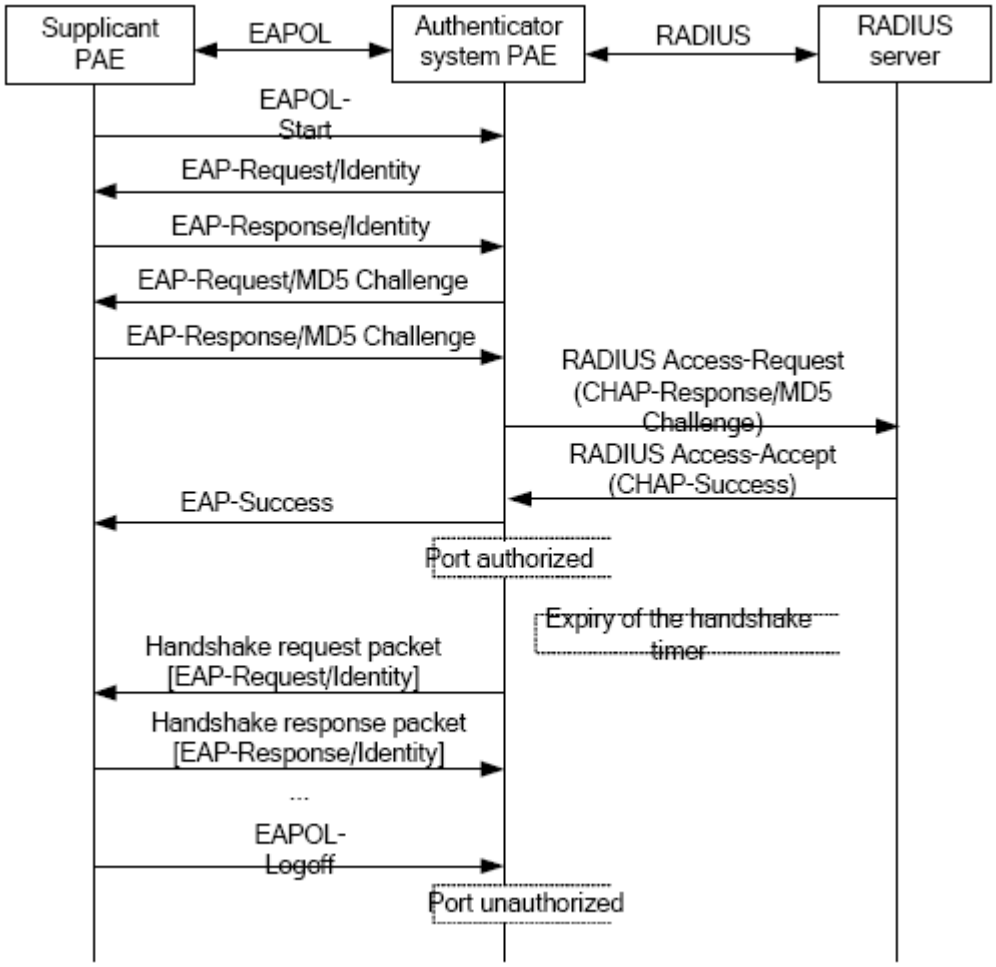


Fig 2-12 the Authentication Flow of 802.1x EAP Termination Mode

2.1.7 The Extension and Optimization of 802.1x

Besides supporting the port- based access authentication method specified by the protocol, devices also extend and optimize it when implementing the EAP relay mode and EAP termination mode of 802.1x.

- ☞ Supports some applications in the case of which one physical port can have more than one users
- ☞ There are three access control methods (the methods to authenticate users): port-based, MAC-based and user-based (IP address+ MAC address+ port).
  - When the port-based method is used, as long as the first user of this port passes the authentication, all the other users can access the network resources without being authenticated. However, once the first user is offline, the network won't be available to all the other users.
  - When the MAC-based method is used, all the users accessing a port should be

authenticated separately, only those pass the authentication can access the network, while the others can not. When one user becomes offline, the other users will not be affected.

- When the user-based (IP address+ MAC address+ port) method is used, all users can access limited resources before being authenticated. There are two kinds of control in this method: standard control and advanced control. The user-based standard control will not restrict the access to limited resources, which means all users of this port can access limited resources before being authenticated. The user-based advanced control will restrict the access to limited resources, only some particular users of the port can access limited resources before being authenticated. Once those users pass the authentication, they can access all resources.

Attention: when using private supplicant systems, user-based advanced control is recommended to effectively prevent ARP cheat.

The maximum number of the authenticated users can be 4000, but less than 2000 will be preferred.

2.1.8 The Features of VLAN Allocation

1. Auto VLAN

Auto VLAN feature enables RADIUS server to change the VLAN to which the access port belongs, based on the user information and the user access device information. When an 802.1x user passes authentication on the server, the RADIUS server will send the authorization information to the device, if the RADIUS server has enabled the VLAN-assigning function, then the following attributes should be included in the Access-Accept messages:

- ☞ Tunnel-Type = VLAN (13)
- ☞ Tunnel-Medium-Type = 802 (6)
- ☞ Tunnel-Private-Group-ID = VLANID

The VLANID here means the VID of VLAN, ranging from 1 to 4094. For example, Tunnel-Private-Group-ID = 30 means VLAN 30.

When the switch receives the assigned Auto VLAN information, the current Access port will leave the VLAN set by the user and join Auto VLAN.

Auto VLAN won't change or affect the port's configuration. But the priority of Auto VLAN is higher than that of the user-set VLAN, that is Auto VLAN is the one takes effect when the authentication is finished, while the user-set VLAN do not work until the user become offline.

Notes: At present, Auto VLAN can only be used in the port-based access control mode, and on the ports whose link type is Access.

2. Guest VLAN

Guest VLAN feature is used to allow the unauthenticated user to access some specified resources.

The user authentication port belongs to a default VLAN (Guest VLAN) before passing the 802.1x authentication, with the right to access the resources within this VLAN without authentication. But the resources in other networks are beyond reach. Once authenticated, the port will leave Guest VLAN, and the user can access the resources of other networks.

In Guest VLAN, users can get 802.1x supplicant system software, update supplicant system or update some other applications (such as anti-virus software, the patches of operating system). The access device will add the port into Guest VLAN if there is no supplicant getting authenticated successfully in a certain stretch of time because of lacking exclusive authentication supplicant system or the version of the supplicant system being too low.

Once the 802.1x feature is enabled and the Guest VLAN is configured properly, a port will be added into Guest VLAN, just like Auto VLAN, if there is no response message from the supplicant system after the device sends more authentication-triggering messages than the upper limit (EAP-Request/Identity) from the port.

- ☞ The authentication server assigns an Auto VLAN, and then the port leaves Guest VLAN and joins the assigned Auto VLAN. When the user becomes offline, the port will be allocated to the specified Guest VLAN again.
- ☞ The authentication server assigns an Auto VLAN, and then the port leaves Guest VLAN and joins the specified VLAN. When the user becomes offline, the port will be allocated to the specified Guest VLAN again.

2.2 802.1x Configuration Task List

802.1x Configuration Task List:

1. Enable IEEE 802.1x function
2. Configure web authentication agent function
3. Access management unit property configuration
    1) Configure port authentication status
    2) Configure access management method for the port: MAC-based or port-based.
    3) Configure expanded 802.1x function
    4) Configure IPv6 passthrough function of the port
4. User access devices related property configuration (optional)

1. Enable 802.1x function

Command	Explanation
Global Mode	
dot1x enable **no dot1x enable**	Enables the 802.1x function in the switch and ports; the no command disables the 802.1x function.
dot1x privateclient enable **no dot1x privateclient enable**	Enables the switch force client software using private 802.1x authentication packet format. The no command will disable this function.
dot1x user free-resource *<prefix> <mask>* **no dot1x user free-resource**	Sets free access network resource for unauthorized dot1x user. The no command closes the resource.
dot1x unicast enable **no dot1x unicast enable**	Enable the 802.1x unicast passthrough function of switch; the no operation of this command will disable this function.

2. Configure Web authentication agent function

Command	Explanation
Global Mode	
dot1x web authentication enable **no dot1x web authentication enable**	Enable Web authentication agent, the no command disable Web authentication agent.
dot1x web redirect *<URL>* **no dot1x web redirect**	Set the HTTP server address for Web redirection, the no command clears the address.

3. Access management unit property configuration

1) Configure port authentication status

Command	Explanation
Port Mode	
dot1x port-control {auto|force-authorized|force-unauthorized } **no dot1x port-control**	Sets the 802.1x authentication mode; the no command restores the default setting.

2) Configure port access management method

Command	Explanation
Port Mode	

dot1x port-method {macbased | portbased | webbased | userbased {standard | advanced}} **no dot1x port-method**	Sets the port access management method; the no command restores MAC-based access management.
dot1x max-user macbased <*number*> **no dot1x max-user macbased**	Sets the maximum number of access users for the specified port; the no command restores the default setting of allowing 1 user.
dot1x max-user userbased <*number*> **no dot1x max-user userbased**	Set the upper limit of the number of users allowed accessing the specified port, only used when the access control mode of the port is userbased; the no command is used to reset the limit to 10 by default.
dot1x guest-vlan <*vlanID*> **no dot1x guest-vlan**	Set the guest vlan of the specified port; the no command is used to delete the guest vlan.
dot1x portbased mode single-mode **no dot1x portbased mode single-mode**	Set the single-mode based on portbase authentication mode; the no command disables this function.

3) Configure expanded 802.1x function

Command	Explanation
Global Mode	
dot1x macfilter enable **no dot1x macfilter enable**	Enables the 802.1x address filter function in the switch; the no command disables the 802.1x address filter function.
dot1x macbased port-down-flush **no dot1x macbased port-down-flush**	Enables this command, when the dot1x certification according to mac is down, delete the user who passed the certification of the port; The no command does not make the down operation.
dot1x accept-mac <*mac-address*> [interface <*interface-name*>] **no dot1x accept-mac <*mac-address*> [interface <*interface-name*>]**	Adds 802.1x address filter table entry, the no command deletes 802.1x filter address table entries.

dot1x eapor enable **no dot1x eapor enable**	Enables the EAP relay authentication function in the switch; the no command sets EAP local end authentication.

4) Configure IPv6 passthrough function of the port

Command	Explanation
Port Mode	
dot1x ipv6 passthrough **no dot1x ipv6 passthrough**	Enables IPv6 passthrough function of port on a switch, only applicable when access control mode is userbased; the no operation of this command will disable the function.
dot1x web authentication ipv6 passthrough **no dot1x web authentication ipv6 passthrough**	Enable IPv6 passthrough function on a switch port, only applicable when access control mode is webbased; the no operation of this command will disable the function.

4. Supplicant related property configuration

Command	Explanation
Global Mode	
dot1x max-req <*count*> **no dot1x max-req**	Sets the number of EAP request/MD5 frame to be sent before the switch re-initials authentication on no supplicant response, the no command restores the default setting.
dot1x re-authentication **no dot1x re-authentication**	Enables periodical supplicant authentication; the no command disables this function.
dot1x timeout quiet-period <*seconds*> **no dot1x timeout quiet-period**	Sets time to keep silent on port authentication failure; the no command restores the default value.
dot1x timeout re-authperiod <*seconds*> **no dot1x timeout re-authperiod**	Sets the supplicant re-authentication interval; the no command restores the default setting.
dot1x timeout tx-period <*seconds*> **no dot1x timeout tx-period**	Sets the interval for the supplicant to re-transmit EAP request/identity frame; the no command restores the default setting.

dot1x re-authenticate [interface *<interface-name>*]	Enables IEEE 802.1x re-authentication (no wait timeout requires) for all ports or a specified port.

2.3 802.1x Application Example

2.3.1 Examples of Guest Vlan Applications

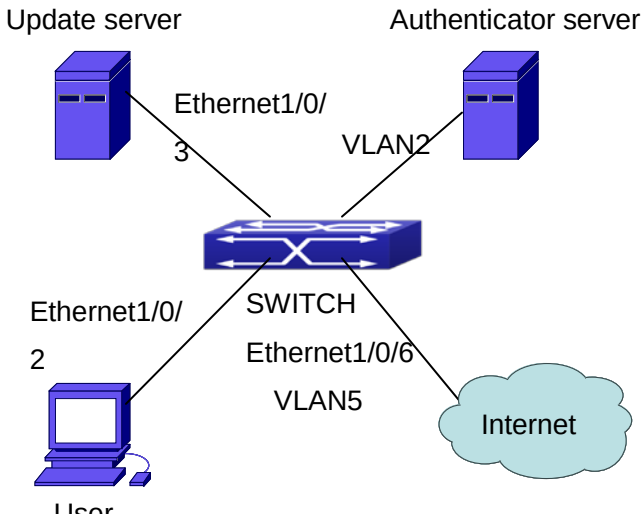


Fig 2-13 The Network Topology of Guest VLAN

Notes: in the figures in this session, E2 means Ethernet 1/0/2, E3 means Ethernet 1/0/3 and E6 means Ethernet 1/0/6.

As showed in the next figure, a switch accesses the network using 802.1x authentication, with a RADIUS server as its authentication server. Ethernet1/0/2, the port through which the user accesses the switch belongs to VLAN100; the authentication server is in VLAN2; Update Server, being in VLAN10, is for the user to download and update supplicant system software; Ethernet1/0/6, the port used by the switch to access the Internet is in VLAN5.

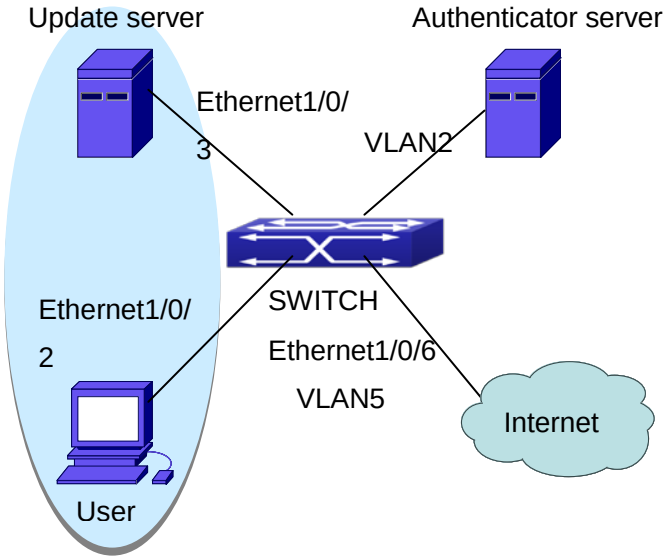


Fig 2-14 User Joining Guest VLAN

As illustrated in the up figure, on the switch port Ethernet1/0/2, the 802.1x feature is enabled, and the VLAN10 is set as the port's Guest VLAN. Before the user gets authenticated or when the user fails to do so, port Ethernet1/0/2 is added into VLAN10, allowing the user to access the Update Server.

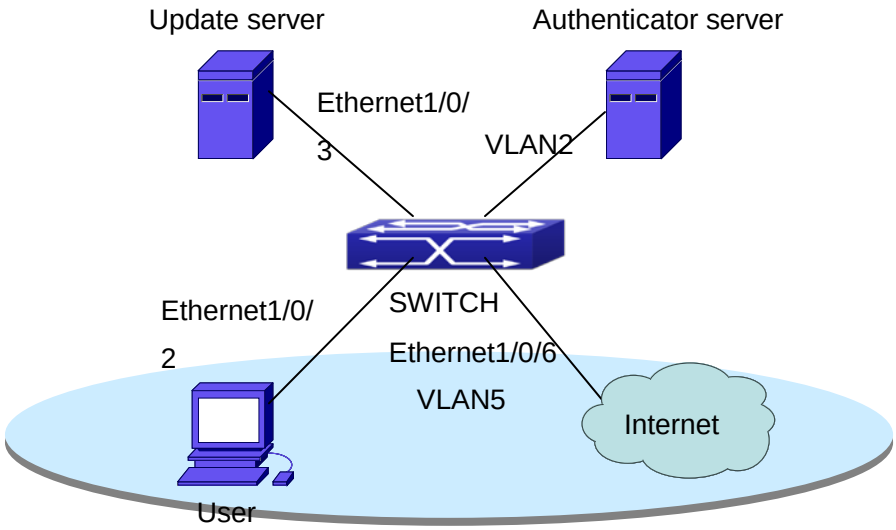


Fig 2-15 User Being Online, VLAN Being Offline

As illustrated in the up figure, when the users become online after a successful authentication, the authentication server will assign VLAN5, which makes the user and Ethernet1/0/6 both in VLAN5, allowing the user to access the Internet.

The following are configuration steps:

Configure RADIUS server.

```
Switch(config)#radius-server authentication host 10.1.1.3
Switch(config)#radius-server accounting host 10.1.1.3
Switch(config)#radius-server key test
Switch(config)#aaa enable
Switch(config)#aaa-accounting enable

# Create VLAN100.
Switch(config)#vlan 100

# Enable the global 802.1x function
Switch(config)#dot1x enable

# Enable the 802.1x function on port Ethernet1/0/2
Switch(config)#interface ethernet1/0/2
Switch(Config-If-Ethernet1/0/2)#dot1x enable

# Set the link type of the port as access mode.
Switch(Config-If-Ethernet1/0/2)#switch-port mode access

# Set the access control mode on the port as portbased.
Switch(Config-If-Ethernet1/0/2)#dot1x port-method portbased

# Set the access control mode on the port as auto.
Switch(Config-If-Ethernet1/0/2)#dot1x port-control auto

# Set the port's Guest VLAN as 100.
Switch(Config-If-Ethernet1/0/2)#dot1x guest-vlan 100
Switch(Config-If-Ethernet1/0/2)#exit
```

Using the command of **show running-config** or **show interface ethernet**1/0/2, users can check the configuration of Guest VLAN. When there is no online user, no failed user authentication or no user gets offline successfully, and more authentication-triggering messages (EAP-Request/Identity) are sent than the upper limit defined, users can check whether the Guest VLAN configured on the port takes effect with the command **show vlan id 100**.

2.3.2 Examples of IPv4 Radius Applications

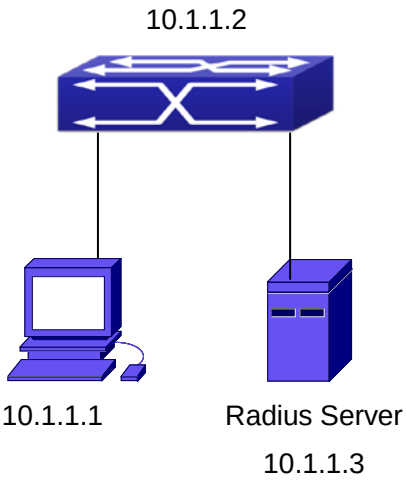


Fig 2-16 IEEE 802.1x Configuration Example Topology

The PC is connecting to port 1/0/2 of the switch; IEEE 802.1x authentication is enabled on port1/0/2; the access mode is the default MAC-based authentication. The switch IP address is 10.1.1.2. Any port other than port 1/0/2 is used to connect to RADIUS authentication server, which has an IP address of 10.1.1.3, and use the default port 1812 for authentication and port 1813 for accounting. IEEE 802.1x authentication client software is installed on the PC and is used in IEEE 802.1x authentication.

The configuration procedures are listed below:

Switch(config)#interface vlan 1
Switch(Config-if-vlan1)#ip address 10.1.1.2 255.255.255.0
Switch(Config-if-vlan1)#exit
Switch(config)#radius-server authentication host 10.1.1.3
Switch(config)#radius-server accounting host 10.1.1.3
Switch(config)#radius-server key test
Switch(config)#aaa enable
Switch(config)#aaa-accounting enable
Switch(config)#dot1x enable
Switch(config)#interface ethernet 1/0/2
Switch(Config-If-Ethernet1/0/2)#dot1x enable
Switch(Config-If-Ethernet1/0/2)#dot1x port-control auto
Switch(Config-If-Ethernet1/0/2)#exit

2.3.3 Examples of IPv6 Radius Application

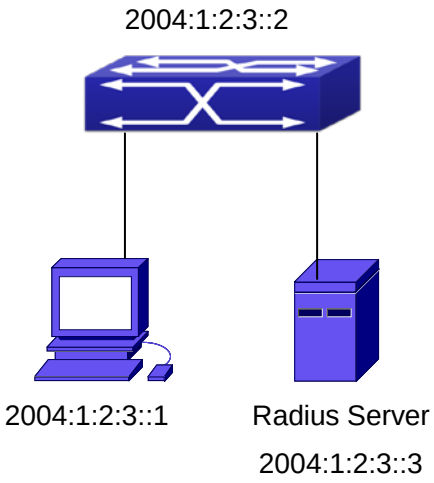


Fig 2-17 IPv6 Radius

Connect the computer to the interface 1/0/2 of the switch, and enable IEEE802.1x on interface1/0/2. Use MAC based authentication. Configure the IP address of the switch as 2004:1:2:3::2, and connect the switch with any interface except interface 1/0/2 to the RADIUS authentication server. Configure the IP address of the RADIUS server to be 2004:1:2:3::3. Use the default ports 1812 and 1813 for authentication and accounting respectively. Install the IEEE802.1x authentication client software on the computer, and use the client for IEEE802.1x authentication.

The detailed configurations are listed as below:

Switch(config)#interface vlan 1
Switch(Config-if-vlan1)#ipv6 address 2004:1:2:3::2/64
Switch(Config-if-vlan1)#exit
Switch(config)#radius-server authentication host 2004:1:2:3::3
Switch(config)#radius-server accounting host 2004:1:2:3::3
Switch(config)#radius-server key test
Switch(config)#aaa enable
Switch(config)#aaa-accounting enable
Switch(config)#dot1x enable
Switch(config)#interface ethernet 1/0/2
Switch(Config-If-Ethernet1/0/2)#dot1x enable
Switch(Config-If-Ethernet1/0/2)#dot1x port-control auto
Switch(Config-If-Ethernet1/0/2)#exit

2.3.4 802.1x Web Proxy Authentication Sample Application

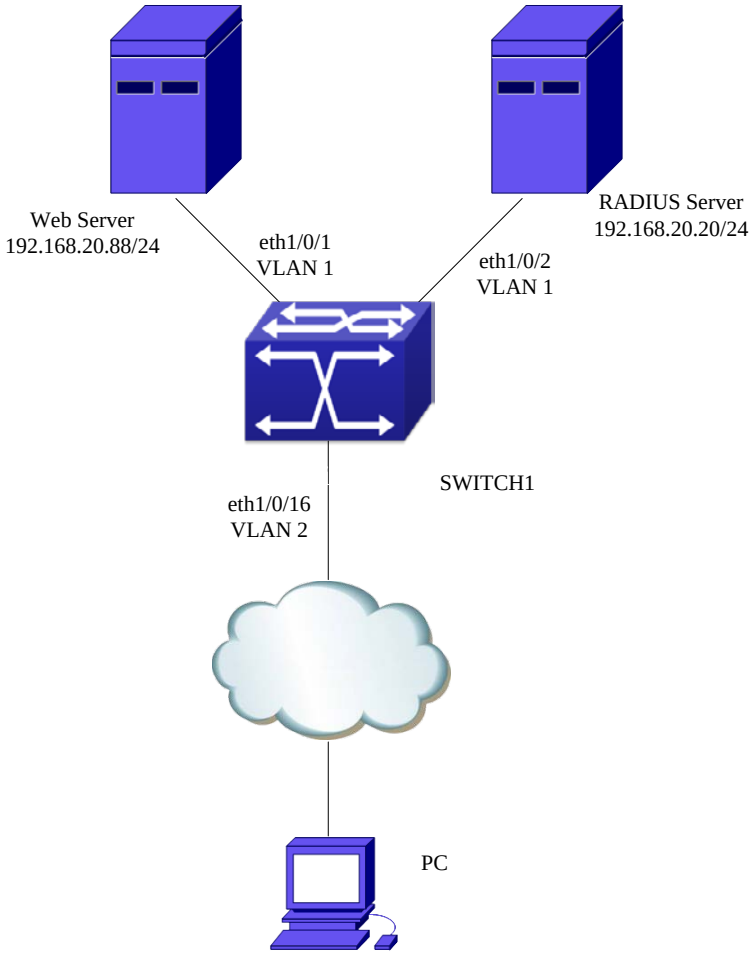


Fig 2-18 802.1x Web Authentication Typical Configuration

In the network topology shown as above, Ethernet 1/0/1 on SWITCH1 is connected to the Web server whose IP address is 192.168.20.20/24, Ethernet 1/0/2 on SWITCH1 is connected to the RADIUS server whose IP address is 192.168.20.88/24 and authentication port is 1812. PC is connected to Ethernet 1/0/16 on SWITCH1 through an unknown network. The Web server and the authentication server are connected to VLAN 1, while PC is connected to VLAN 2. 802.1x Web authentication can be enabled through the following configuration. The re-authentication function is disabled by default. To enable this, corresponding 802.1x configuration should be issued first.

Configuration task list on SWITCH1

Switch(config)#dot1x enable

Switch(config)#dot1x web authentication enable

Switch(config)#dot1x web redirect http://192.168.20.20/WebSupplicant/

Switch(config)#interface ethernet 1/0/16

Switch(Config-If-Ethernet1/0/16)#dot1x enable

Switch(Config-If-Ethernet1/0/16)#dot1x port-method webbased

2.4 802.1x Troubleshooting

It is possible that 802.1x be configured on ports and 802.1x authentication be set to auto, t switch can't be to authenticated state after the user runs 802.1x supplicant software. Here are some possible causes and solutions:

- ☞ If 802.1x cannot be enabled for a port, make sure the port is not executing MAC binding, or configured as a port aggregation. To enable the 802.1x authentication, the above functions must be disabled.
- ☞ If the switch is configured properly but still cannot pass through authentication, connectivity between the switch and RADIUS server, the switch and 802.1x client should be verified, and the port and VLAN configuration for the switch should be checked, too.
- ☞ Check the event log in the RADIUS server for possible causes. In the event log, not only unsuccessful logins are recorded, but prompts for the causes of unsuccessful login. If the event log indicates wrong authenticator password, radius-server key parameter shall be modified; if the event log indicates no such authenticator, the authenticator needs to be added to the RADIUS server; if the event log indicates no such login user, the user login ID and password may be wrong and should be verified and input again.
- ☞ Web Authentication Proxy based on 802.1x is disabled by default. Open the debug dot1x switch to check debugging information when the Web Authentication Proxy based on 802.1x is opened.
- ☞ If the state display of the port is not disabled when use show dot1x, that means the Web Authentication Proxy function based on 802.1x is not close it.
- ☞ The switch of the Web Authentication Proxy based on 802.1x achieves less than 1024 users who had authenticated simultaneity on line. If exceeds this limit will return hint information.
- ☞ When the Web Authentication is failed should check whether the **dot1x privateclient enable** command is enabled, if the command had been enabled, then the private authentication function need close.

Chapter 3 The Number Limitation Function of MAC and IP in Port, VLAN Configuration

3.1 Introduction to the Number Limitation Function of MAC and IP in Port, VLAN

MAC address list is used to identify the mapping relationship between the destination MAC addresses and the ports of switch. There are two kinds of MAC addresses in the list: static MAC address and dynamic MAC address. The static MAC address is set by users, having the highest priority (will not be overwritten by dynamic MAC address), and will always be effective; dynamic MAC address is learnt by the switch through transmitting data frames, and will only be effective in a specific time range. When the switch receives a data framed waiting to be transmitted, it will study the source MAC address of the data frame, build a mapping relationship with the receiving port, and then look up the MAC address list for the destination MAC address. If any matching list entry is found, the switch will transmit the data frame via the corresponding port, or, the switch will broadcast the data frame over the VLAN it belongs to. If the dynamically learnt MAC address matches no transmitted data in a long time, the switch will delete it from the MAC address list.

Usually the switch supports both the static configuration and dynamic study of MAC address, which means each port can have more than one static set MAC addresses and dynamically learnt MAC addresses, and thus can implement the transmission of data traffic between port and known MAC addresses. When a MAC address becomes out of date, it will be dealt with broadcast. No number limitation is put on MAC address of the ports of our current switches; every port can have several MAC addressed either by configuration or study, until the hardware list entries are exhausted. To avoid too many MAC addresses of a port, we should limit the number of MAC addresses a port can have.

For each INTERFACE VLAN, there is no number limitation of IP; the upper limit of the number of IP is the upper limit of the number of user on an interface, which is, at the same time, the upper limit of ARP and ND list entry. There is no relative configuration command can be used to control the sent number of these list entries. To enhance the security and the controllability of our products, we need to control the number of MAC address on each port and the number of ARP, ND on each INTERFACE VLAN. The number of static or dynamic MAC address on a port should not exceed the configuration. The number of user

on each VLAN should not exceed the configuration, either.

Limiting the number of MAC and ARP list entry can avoid DOS attack to a certain extent. When malicious users frequently do MAC or ARP cheating, it will be easy for them to fill the MAC and ARP list entries of the switch, causing successful DOS attacks.

To summer up, it is very meaningful to develop the number limitation function of MAC and IP in port, VLAN. Switch can control the number of MAC address of ports and the number ARP, ND list entry of ports and VLAN through configuration commands.

Limiting the number of dynamic MAC and IP of ports:

1. Limiting the number of dynamic MAC. If the number of dynamically learnt MAC address by the switch is already larger than or equal with the max number of dynamic MAC address, then shutdown the MAC study function on this port, otherwise, the port can continue its study.

2. Limiting the number of dynamic IP. If the number of dynamically learnt ARP and ND by the switch is already larger than or equal with the max number of dynamic ARP and ND, then shutdown the ARP and ND study function of this port, otherwise, the port can continue its study.

Limiting the number of MAC, ARP and ND of interfaces:

1. Limiting the number of dynamic MAC. If the number of dynamically learnt MAC address by the VLAN of the switch is already larger than or equal with the max number of dynamic MAC address, then shutdown the MAC study function of all the ports in this VLAN, otherwise, all the ports in this VLAN can continue their study (except special ports).

2. Limiting the number of dynamic IP. If the number of dynamically learnt ARP and ND by the switch is already larger than or equal with the max number of dynamic ARP and ND, then the VLAN will not study any new ARP or ND, otherwise, the study can be continued.

3.2 The Number Limitation Function of MAC and IP in Port, VLAN Configuration Task Sequence

1. Enable the number limitation function of MAC and IP on ports
2. Enable the number limitation function of MAC and IP in VLAN
3. Configure the timeout value of querying dynamic MAC
4. Configure the violation mode of ports
5. Display and debug the relative information of number limitation of MAC and IP on ports

1. Enable the number limitation function of MAC and IP on ports

Command	Explanation
Port configuration mode	

switchport mac-address dynamic maximum <*value*> **no switchport mac-address dynamic maximum**	Enable and disable the number limitation function of MAC on the ports.
switchport arp dynamic maximum <*value*> **no switchport arp dynamic maximum**	Enable and disable the number limitation function of ARP on the ports.
switchport nd dynamic maximum <*value*> **no switchport nd dynamic maximum**	Enable and disable the number limitation function of ND on the ports.

2. Enable the number limitation function of MAC and IP in VLAN

Command	Explanation
VLAN configuration mode	
vlan mac-address dynamic maximum <*value*> **no vlan mac-address dynamic maximum**	Enable and disable the number limitation function of MAC in the VLAN.
Interface configuration mode	
ip arp dynamic maximum <*value*> **no ip arp dynamic maximum**	Enable and disable the number limitation function of ARP in the VLAN.
ipv6 nd dynamic maximum <*value*> **no ipv6 nd dynamic maximum**	Enable and disable the number limitation function of NEIGHBOR in the VLAN.

3. Configure the timeout value of querying dynamic MAC

Command	Explanation
Global configuration mode	
mac-address query timeout <seconds>	Configure the timeout value of querying dynamic MAC.

4. Configure the violation mode of ports

Command	Explanation
Port mode	
switchport mac-address violation {protect | shutdown} [recovery <5-3600>] **no switchport mac-address violation**	Set the violation mode of the port, the no command restores the violation mode to **protect**.

5. Display and debug the relative information of number limitation of MAC and IP on ports

Command	Explanation
Admin mode	
show mac-address dynamic count {vlan <*vlan-id*> | interface ethernet <portName> }	Display the number of dynamic MAC in corresponding ports and VLAN.
show arp-dynamic count {vlan <vlan-id> | interface ethernet <*portName*> }	Display the number of dynamic ARP in corresponding ports and VLAN.
show nd-dynamic count {vlan <*vlan-id*> | interface ethernet <*portName*> }	Display the number of dynamic NEIGHBOUR in corresponding ports and VLAN.
debug switchport mac count **no debug switchport mac count**	All kinds of debug information when limiting the number of MAC on ports.
debug switchport arp count **no debug switchport arp count**	All kinds of debug information when limiting the number of ARP on ports.
debug switchport nd count **no debug switchport nd count**	All kinds of debug information when limiting the number of NEIGHBOUR on ports.
debug vlan mac count **no debug vlan mac count**	All kinds of debug information when limiting the number of MAC in VLAN.
debug ip arp count **no debug ip arp count**	All kinds of debug information when limiting the number of ARP in VLAN.
debug ipv6 nd count **no debug ipv6 nd count**	All kinds of debug information when limiting the number of NEIGHBOUR in VLAN.

3.3 The Number Limitation Function of MAC and IP in Port, VLAN Typical Examples

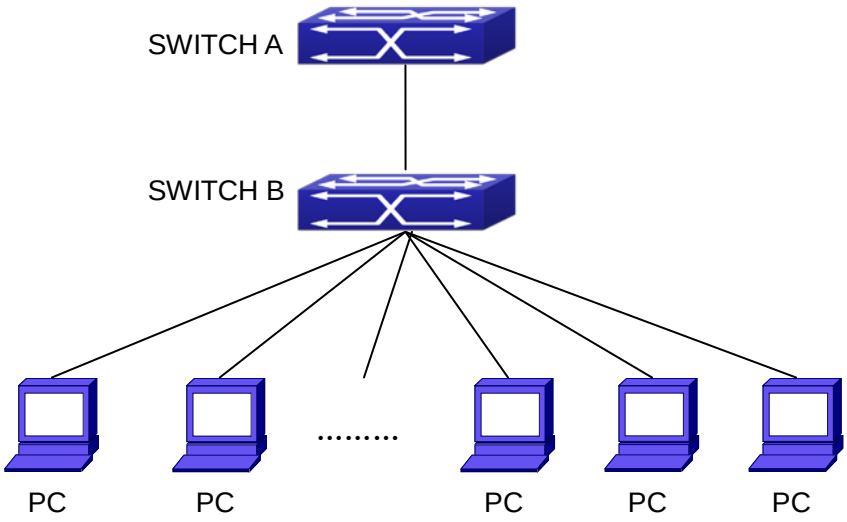


Fig 3-1 The Number Limitation of MAC and IP in Port, VLAN Typical Configuration Example

In the network topology above, SWITCH B connects to many PC users, before enabling the number limitation function of MAC and IP in Port, VLAN, if the system hardware has no other limitation, SWTICH A and SWTICH B can get the MAC, ARP, ND list entries of all the PC, so limiting the MAC, ARP list entry can avoid DOS attack to a certain extent. When malicious users frequently do MAC, ARP cheating, it will be easy for them to fill the MAC, ARP list entries of the switch, causing successful DOS attacks. Limiting the MAC, ARP, ND list entry can prevent DOS attack.

On port 1/0/1 of SWITCH A, set the max number can be learnt of dynamic MAC address as 20, dynamic ARP address as 20, NEIGHBOR list entry as 10. In VLAN 1, set the max number of dynamic MAC address as 30, of dynamic ARP address as 30, NEIGHBOR list entry as 20.

SWITCH A configuration task sequence:

```
Switch (config)#interface ethernet 1/0/1
Switch (Config-If-Ethernet1/0/1)#switchport mac-address dynamic maximum 20
Switch (Config-If-Ethernet1/0/1)#switchport arp dynamic maximum 20
Switch (Config-If-Ethernet1/0/1)#switchport nd dynamic maximum 10
Switch (Config-if-Vlan1)#vlan mac-address dynamic maximum 30
```

3.4 The Number Limitation Function of MAC and IP in Port, VLAN Troubleshooting Help

The number limitation function of MAC and IP in Port, VLAN is disabled by default, if users need to limit the number of user accessing the network, they can enable it. If the number limitation function of MAC address can not be configured, please check whether Spanning-tree, dot1x, TRUNK is running on the switch and whether the port is configured as a MAC-binding port. The number limitation function of MAC address is mutually exclusive to these configurations, so if the users need to enable the number limitation function of MAC address on the port, they should check these functions mentioned above on this port are disabled.

If all the configurations are normal, after enabling the number limitation function of MAC and IP in Port, VLAN, users can use debug commands to debug every limitation, check the details of number limitations and judge whether the number limitation function is correct. If there is any problem, please sent result to technical service center.

Chapter 4 Operational Configuration of AM Function

4.1 Introduction to AM Function

AM (Access Management) means that when a switch receives an IP or ARP message, it will compare the information extracted from the message (such as source IP address or source MAC-IP address) with the configured hardware address pool. If there is an entry in the address pool matching the information (source IP address or source MAC-IP address), the message will be forwarded, otherwise, dumped. The reason why source-IP-based AM should be supplemented by source-MAC-IP-based AM is that IP address of a host might change. Only with a bound IP, can users change the IP of the host into forwarding IP, and hence enable the messages from the host to be forwarded by the switch. Given the fact that MAC-IP can be exclusively bound with a host, it is necessary to make MAC-IP bound with a host for the purpose of preventing users from maliciously modifying host IP to forward the messages from their hosts via the switch.

With the interface-bound attribute of AM, network mangers can bind the IP (MAC-IP) address of a legal user to a specified interface. After that, only the messages sending by users with specified IP (MAC-IP) addresses can be forwarded via the interface, and thus strengthen the monitoring of the network security.

4.2 AM Function Configuration Task List

1. Enable AM function
2. Enable AM function on an interface
3. Configure the forwarding IP
4. Configure the forwarding MAC-IP
5. Delete all of the configured IP or MAC-IP or both
6. Display relative configuration information of AM

1. Enable AM function

Command	Explanation
Global Mode	
am enable **no am enable**	Globally enable or disable AM function.

2. Enable AM function on an interface

Command	Explanation
Port Mode	
am port **no am port**	Enable/disable AM function on the port. When the AM function is enabled on the port, no IP or ARP message will be forwarded by default.

3. Configure the forwarding IP

Command	Explanation
Port Mode	
am ip-pool <*ip-address*> <*num*> **no am ip-pool <*ip-address*> <*num*>**	Configure the forwarding IP of the port.

4. Configure the forwarding MAC-IP

Command	Explanation
Port Mode	
am mac-ip-pool <*mac-address*> <*ip-address*> **no am mac-ip-pool <*mac-address*> <*ip-address*>**	Configure the forwarding MAC-IP of the port.

5. Delete all of the configured IP or MAC-IP or both

Command	Explanation
Global Mode	
no am all [ip-pool|mac-ip-pool]	Delete MAC-IP address pool or IP address pool or both pools configured by all users.

6. Display relative configuration information of AM

Command	Explanation
Global Configuration Mode	
show am [interface <*interface-name*>]	Display the AM configuration information of one port or all ports.

4.3 AM Function Example

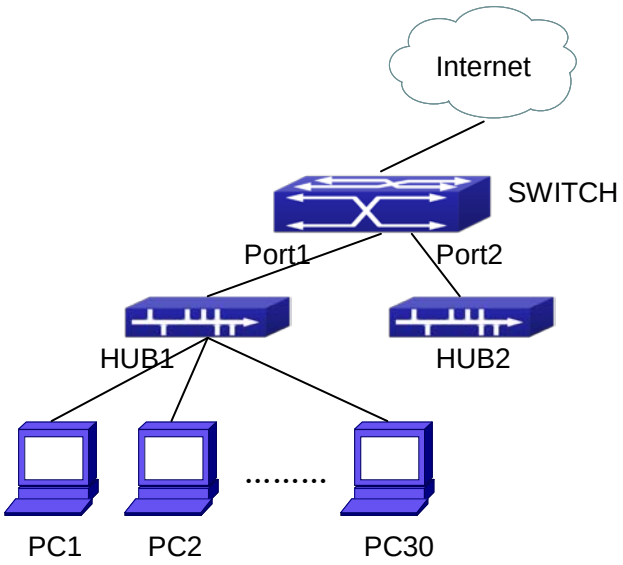


Fig 4-1 a typical configuration example of AM function

In the topology above, 30 PCs, after converged by HUB1, connect with interface1 on the switch. The IP addresses of these 30 PCs range from 100.10.10.1 to 100.10.10.30. Considering security, the system manager will only take user with an IP address within that range as legal ones. And the switch will only forward data packets from legal users while dumping packets from other users.

According to the requirements mentioned above, the switch can be configured as follows:

Switch(config)#am enable

Switch(config)#interface ethernet1/0/1

Switch(Config-If-Ethernet 1/0/1)#am port

Switch(Config-If-Ethernet 1/0/1)#am ip-pool 10.10.10.1 10

4.4 AM Function Troubleshooting

AM function is disabled by default, and after it is enabled, relative configuration of AM can be made.

Users can view the current AM configuration with “show am” command, such as whether the AM is enabled or not, and AM information on each interface, they can also use “**show am [interface *<interface-name>*]**” command to check the AM configuration information on a specific interface.

If any operational error happens, the system will display detailed corresponding

prompt.

Chapter 5 Security Feature Configuration

5.1 Introduction to Security Feature

Before introducing the security features, we here first introduce the DoS. The DoS is short for Denial of Service, which is a simple but effective destructive attack on the internet. The server under DoS attack will drop normal user data packet due to non-stop processing the attacker's data packet, leading to the denial of the service and worse can lead to leak of sensitive data of the server.

Security feature refers to applications such as protocol check which is for protecting the server from attacks such as DoS. The protocol check allows the user to drop matched packets based on specified conditions. The security features provide several simple and effective protections against Dos attacks while acting no influence on the linear forwarding performance of the switch.

5.2 Security Feature Configuration

5.2.1 Prevent IP Spoofing Function Configuration Task Sequence

1. Enable the IP spoofing function.

Command	Explanation
Global Mode	
[no] dosattack-check srcip-equal-dstip enable	Enable/disable the function of checking if the IP source address is the same as the destination address.

5.2.2 Prevent TCP Unauthorized Label Attack Function Configuration Task Sequence

1. Enable the anti TCP unauthorized label attack function
2. Enable Checking IPv4 fragment function

Command	Explanation
Global Mode	
[no] dosattack-check tcp-flags enable	Enable/disable checking TCP label function.
[no] dosattack-check ipv4-first-fragment enable	Enable/disable checking IPv4 fragment. This command has no effect when used separately, but if this function is not enabled, the switch will not drop the IPv4 fragment packet containing unauthorized TCP labels.

5.2.3 Anti Port Cheat Function Configuration Task Sequence

1. Enable the anti port cheat function

Command	Explanation
Global Mode	
[no] dosattack-check srcport-equal-dstport enable	Enable/disable the prevent-port-cheat function.
[no] dosattack-check ipv4-first-fragment enable	Enable/disable checking IPv4 fragment. This command has no effect when used separately, but if this function is not enabled, the switch will not drop the IPv4 fragment packet whose source port is equal to its destination port.

5.2.4 Prevent TCP Fragment Attack Function Configuration Task Sequence

1. Enable the prevent TCP fragment attack function
2. Configure the minimum permitted TCP head length of the packet

Command	Explanation
Global Mode	
[no] dosattack-check tcp-fragment enable	Enable/disable the prevent TCP fragment attack function.

dosattack-check tcp-header <*size*>	Configure the minimum permitted TCP head length of the packet. This command has no effect when used separately, the user should enable the **dosattack-check tcp-fragment enable**.

5.2.5 Prevent ICMP Fragment Attack Function Configuration Task Sequence

1. Enable the prevent ICMP fragment attack function
2. Configure the max permitted ICMPv4 net load length
3. Configure the max permitted ICMPv6 net load length

Command	Explanation
Global Mode	
[no] dosattack-check icmp-attacking enable	Enable/disable the prevent ICMP fragment attack function.
dosattack-check icmpv4-size <*size*>	Configure the max permitted ICMPv4 net load length. This command has not effect when used separately, the user have to enable the **dosattack-check icmp-attacking enable**.
dosattack-check icmpv6-size <*size*>	Configure the max permitted ICMPv6 net load length. This command has not effect when used separately, the user have to enable the **dosattack-check icmp-attacking enable**.

5.3 Security Feature Example

Scenario:

The User has follows configuration requirements: the switch do not forward data packet whose source IP address is equal to the destination address, and those whose source port is equal to the destination port. Only the ping command with defaulted options is allowed within the IPv4 network, namely the ICMP request packet can not be

fragmented and its net length is normally smaller than 100.

Configuration procedure:

Switch(config)# dosattack-check srcip-equal-dstip enable

Switch(config)# dosattack-check srcport-equal-dstport enable

Switch(config)# dosattack-check ipv4-first-fragment enable

Switch(config)# dosattack-check icmp-attacking enable

Switch(config)# dosattack-check icmpV4-size 100

Chapter 6 TACACS+ Configuration

6.1 Introduction to TACACS+

TACACS+ terminal access controller access control protocol is a protocol similar to the radius protocol for control the terminal access to the network. Three independent functions of Authentication, Authorization, Accounting are also available in this protocol. Compared with RADIUS, the transmission layer of TACACS+ protocol is adopted with TCP protocol, further with the packet head (except for standard packet head) encryption, this protocol is of a more reliable transmission and encryption characteristics, and is more adapted to security control.

According to the characteristics of the TACACS+ (Version 1.78), we provide TACACS+ authentication function on the switch, when the user logs, such as telnet, the authentication of user name and password can be carried out with TACACS+.

6.2 TACACS+ Configuration Task List

1. Configure the TACACS+ authentication key
2. Configure the TACACS+ server
3. Configure the TACACS+ authentication timeout time
4. Configure the IP address of the RADIUS NAS

1. Configure the TACACS+ authentication key

Command	Explanation
Global Mode	
tacacs-server key {0 | 7}<*string*> **no tacacs-server key**	Configure the TACACS+ server key; the "**no tacacs-server key**" command deletes the key.

2. Configure TACACS+ server

Command	Explanation
Global Mode	

tacacs-server authentication host <*ip-address*> [port <*port-number*>] [timeout <*seconds*>] [key {0 | 7} <*string*>] [primary] **no tacacs-server authentication host <*ip-address*>**	Configure the IP address, listening port number, the value of timeout timer and the key string of the TACACS+ server; the no form of this command deletes the TACACS+ authentication server.

3. Configure the TACACS+ authentication timeout time

Command	Explanation
Global Mode	
tacacs-server timeout <*seconds*> **no tacacs-server timeout**	Configure the authentication timeout for the TACACS+ server, the "**no tacacs-server timeout**" command restores the default configuration.

4. Configure the IP address of the TACACS+ NAS

Command	Explanation
Global Mode	
tacacs-server nas-ipv4 <*ip-address*> **no tacacs-server nas-ipv4**	To configure the source IP address for the TACACS+ packets for the switch.

6.3 TACACS+ Scenarios Typical Examples

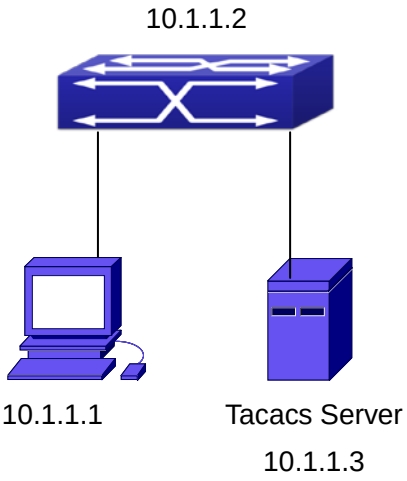


Fig 6-1 TACACS Configuration

A computer connects to a switch, of which the IP address is 10.1.1.2 and connected with a TACACS+ authentication server; IP address of the server is 10.1.1.3 and the authentication port is defaulted at 49, set telnet log on authentication of the switch as tacacs local, via using TACACS+ authentication server to achieve telnet user

authentication.

```
Switch(config)#interface vlan 1
Switch(Config-if-vlan1)#ip address 10.1.1.2 255.255.255.0
Switch(Config-if-vlan1)#exit
Switch(config)#tacacs-server authentication host 10.1.1.3
Switch(config)#tacacs-server key test
Switch(config)#authentication line vty login tacacs
```

6.4 TACACS+ Troubleshooting

In configuring and using TACACS+, the TACACS+ may fail to authentication due to reasons such as physical connection failure or wrong configurations. The user should ensure the following:

- First good condition of the TACACS+ server physical connection.
- Second all interface and link protocols are in the UP state (use "**show interface**" command).
- Then ensure the TACACS+ key configured on the switch is in accordance with the one configured on TACACS+ server.
- Finally ensure to connect to the correct TACACS+ server.

Chapter 7 RADIUS Configuration

7.1 Introduction to RADIUS

7.1.1 AAA and RADIUS Introduction

AAA is short for Authentication, Authorization and Accounting, it provide a consistency framework for the network management safely. According to the three functions of Authentication, Authorization, Accounting, the framework can meet the access control for the security network: which one can visit the network device, which access-level the user can have and the accounting for the network resource.

RADIUS (Remote Authentication Dial in User Service), is a kind of distributed and client/server protocol for information exchange. The RADIUS client is usually used on network appliance to implement AAA in cooperation with 802.1x protocol. The RADIUS server maintains the database for AAA, and communicates with the RADIUS client through RADIUS protocol. The RADIUS protocol is the most common used protocol in the AAA framework.

7.1.2 Message structure for RADIUS

The RADIUS protocol uses UDP to deliver protocol packets. The packet format is shown as below.

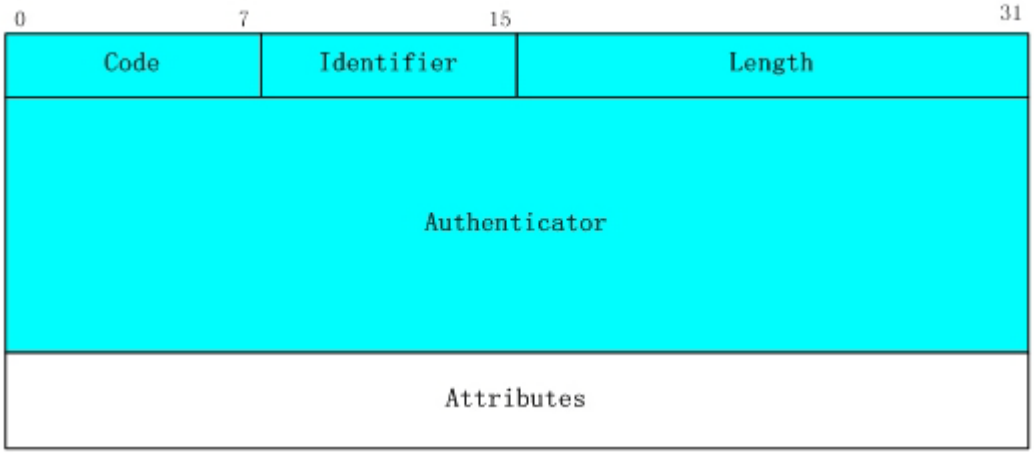


Fig 7-1 Message structure for RADIUS

Code field(1octets): is the type of the RADIUS packet. Available value for the Code field is

show as below:

1 Access-Request
2 Access-Accept
3 Access-Reject
4 Accounting-Request
5 Accounting-Response
11 Access-Challenge

Identifier field (1 octet): Identifier for the request and answer packets.

Length field (2 octets): The length of the overall RADIUS packet, including Code, Identifier, Length, Authenticator and Attributes

Authenticator field (16 octets): used for validation of the packets received from the RADIUS server. Or it can be used to carry encrypted passwords. This field falls into two kinds: the Request Authenticator and the Response Authenticator.

Attribute field: used to carry detailed information about AAA. An Attribute value is formed by Type, Length, and Value fields.

☞ Type field (1 octet), the type of the attribute value, which is shown as below:

Property	Type of property	Property	Type of property
1	User-Name	23	Framed-IPX-Network
2	User-Password	24	State
3	CHAP-Password	25	Class
4	NAS-IP-Address	26	Vendor-Specific
5	NAS-Port	27	Session-Timeout
6	Service-Type	28	Idle-Timeout
7	Framed-Protocol	29	Termination-Action
8	Framed-IP-Address	30	Called-Station-Id
9	Framed-IP-Netmask	31	Calling-Station-Id
10	Framed-Routing	32	NAS-Identifier
11	Filter-Id	33	Proxy-State
12	Framed-MTU	34	Login-LAT-Service
13	Framed-Compression	35	Login-LAT-Node
14	Login-IP-Host	36	Login-LAT-Group
15	Login-Service	37	Framed-AppleTalk-Link
16	Login-TCP-Port	38	Framed-AppleTalk-Network

17	(unassigned)	39	Framed-AppleTalk-Zone
18	Reply-Message	40-59	(reserved for accounting)
19	Callback-Number	60	CHAP-Challenge
20	Callback-Id	61	NAS-Port-Type
21	(unassigned)	62	Port-Limit
22	Framed-Route	63	Login-LAT-Port

- ☞ Length field (1 octet), the length in octets of the attribute including Type, Length and Value fields.
- ☞ Value field, value of the attribute whose content and format is determined by the type and length of the attribute.

7.2 RADIUS Configuration Task List

1. Enable the authentication and accounting function
2. Configure the RADIUS authentication key
3. Configure the RADIUS server
4. Configure the parameter of the RADIUS service
5. Configure the IP address of the RADIUS NAS

1. Enable the authentication and accounting function

Command	Explanation
Global Mode	
aaa enable **no aaa enable**	To enable the AAA authentication function. The no form of this command will disable the AAA authentication function.
aaa-accounting enable **no aaa-accounting enable**	To enable AAA accounting. The no form of this command will disable AAA accounting.
aaa-accounting update {enable|disable}	Enable or disable the update accounting function.

2. Configure the RADIUS authentication key

Command	Explanation
Global Mode	

radius-server key {0 | 7} <*string*> **no radius-server key**	To configure the encryption key for the RADIUS server. The no form of this command will remove the configured key.

3. Configure the RADIUS server

Command	Explanation
Global Mode	
radius-server authentication host {<*ipv4-address*> | <*ipv6-address*>} [port <*port-number*>] [key <string>] [primary] [access-mode {dot1x | telnet | wireless}] **no radius-server authentication host {<*ipv4-address*> | <*ipv6-address*>**	Specifies the IPv4/IPv6 address and the port number, whether be primary server for RADIUS accounting server; the no command deletes the RADIUS accounting server.
radius-server accounting host {<ipv4-address> | <ipv6-address>} [port <port-number>] [key {*0* | 7} <string>] [primary] **no radius-server accounting host {<ipv4-address> | <ipv6-address>}**	Specifies the IPv4/IPv6 address and the port number, whether be primary server for RADIUS accounting server; the no command deletes the RADIUS accounting server.

4. Configure the parameter of the RADIUS service

Command	Explanation
Global Mode	
radius-server dead-time <*minutes*> **no radius-server dead-time**	To configure the interval that the RADIUS becomes available after it is down. The no form of this command will restore the default configuration.
radius-server retransmit <*retries*> **no radius-server retransmit**	To configure retry times for the RADIUS packets. The no form of this command restores the default configuration.
radius-server timeout <*seconds*> **no radius-server timeout**	To configure the timeout value for the RADIUS server. The no form of this command will restore the default configuration.

radius-server accounting-interim-update timeout *<seconds>* **no radius-server accounting-interim-update timeout**	To configure the update interval for accounting. The no form of this command will restore the default configuration.

5. Configure the IP address of the RADIUS NAS

Command	Explanation
Global Mode	
radius nas-ipv4 *<ip-address>* **no radius nas-ipv4**	To configure the source IP address for the RADIUS packets for the switch.
radius nas-ipv6 *<ipv6-address>* **no radius nas-ipv6**	To configure the source IPv6 address for the RADIUS packets for the switch.

7.3 RADIUS Typical Examples

7.3.1 IPv4 Radius Example

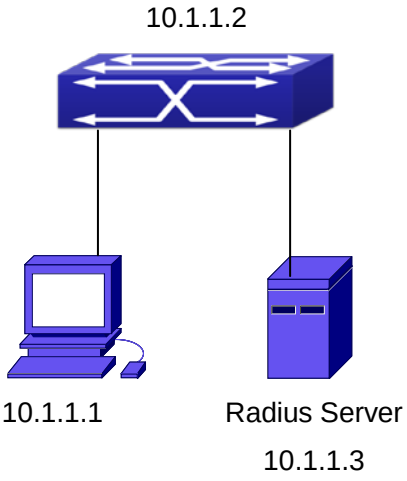


Fig 7-2 The Topology of IEEE802.1x configuration

A computer connects to a switch, of which the IP address is 10.1.1.2 and connected with a RADIUS authentication server without Ethernet1/0/2; IP address of the server is 10.1.1.3 and the authentication port is defaulted at 1812, accounting port is defaulted at 1813.

Configure steps as below:

Switch(config)#interface vlan 1

Switch(Config-if-vlan1)#ip address 10.1.1.2 255.255.255.0

Switch(Config-if-vlan1)#exit

Switch(config)#radius-server authentication host 10.1.1.3

Switch(config)#radius-server accounting host 10.1.1.3

Switch(config)#radius-server key test

Switch(config)#aaa enable

Switch(config)#aaa-accounting enable

7.3.2 IPv6 RadiusExample

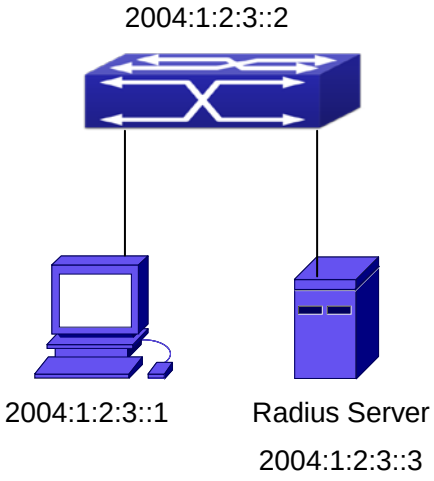


Fig 7-3 The Topology of IPv6 Radius configuration

A computer connects to a switch, of which the IP address is 2004:1:2:3::2 and connected with a RADIUS authentication server without Ethernet1/0/2; IP address of the server is 2004:1:2:3::3 and the authentication port is defaulted at 1812, accounting port is defaulted at 1813.

Configure steps as below:

Switch(config)#interface vlan 1

Switch(Config-if-vlan1)#ipv6 address 2004:1:2:3::2/64

Switch(Config-if-vlan1)#exit

Switch(config)#radius-server authentication host 2004:1:2:3::3

Switch(config)#radius-server accounting host 2004:1:2:3::3

Switch(config)#radius-server key test

Switch(config)#aaa enable

Switch(config)#aaa-accounting enable

7.4 RADIUS Troubleshooting

In configuring and using RADIUS, the RADIUS may fail to authentication due to reasons such as physical connection failure or wrong configurations. The user should ensure the following:

- ☞ First make sure good condition of the RADIUS server physical connection
- ☞ Second all interface and link protocols are in the UP state (use "**show interface**" command)
- ☞ Then ensure the RADIUS key configured on the switch is in accordance with the one configured on RADIUS server
- ☞ Finally ensure to connect to the correct RADIUS server

If the RADIUS authentication problem remains unsolved, please use **debug aaa** and other debugging command and copy the DEBUG message within 3 minutes, send the recorded message to the technical server center of our company.

Chapter 8 SSL Configuration

8.1 Introduction to SSL

As the computer networking technology spreads, the security of the network has been taking more and more important impact on the availability and the usability of the networking application. The network security has become one of the greatest barriers of modern networking applications.

To protect sensitive data transferred through Web, Netscape introduced the Secure Socket Layer – SSL protocol, for its Web browser. Up till now, SSL 2.0 and 3.0 has been released. SSL 2.0 is obsolete because of security problems, and it is not supported on the switches of Network. The SSL protocol uses the public-key encryption, and has become the industry standard for secure communication on internet for Web browsing. The Web browser integrates HTTP and SSL to realize secure communication.

SSL is a safety protocol to protect private data transmission on the Internet. SSL protocols are designed for secure transmission between the client and the server, and authentication both at the server sides and optional client. SSL protocols must build on reliable transport layer (such as TCP). SSL protocols are independent for application layer. Some protocols such as HTTP, FTP, TELNET and so on, can build on SSL protocols transparently. The SSL protocol negotiates for the encryption algorithm, the encryption key and the server authentication before data is transmitted. Ever since the negotiation is done, all the data being transferred will be encrypted.

Via above introduction, the security channel is provided by SSL protocols have below three characteristics:

- ☞ Privacy. First they encrypt the suite through negotiation, then all the messages be encrypted.
- ☞ Affirmation. Though the client authentication of the conversational is optional, but the server is always authenticated.
- ☞ Reliability. The message integrality inspect is included in the sending message (use MAC).

8.1.1 Basic Element of SSL

The basic strategy of SSL provides a safety channel for random application data forwarding between two communication programs. In theory, SSL connect is similar with encrypt TCP connect. The position of SSL protocol is under application layer and on the

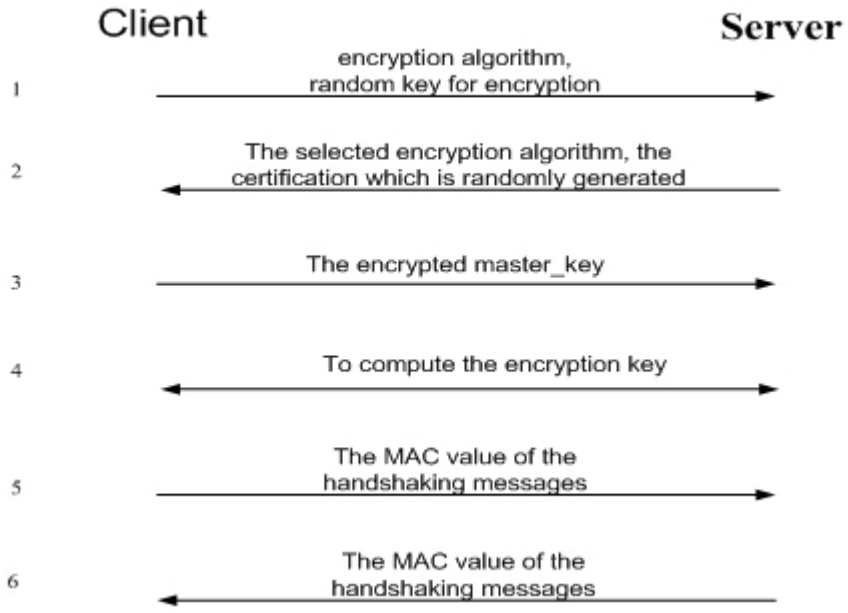
TCP. If the mechanism of the data forwarding in the lower layer is reliable, the data read-in the network will be forwarded to the other program in sequence, lose packet and re-forwarding will not appear. A lot of transmission protocols can provide such kind of service in theory, but in actual application, SSL is almost running on TCP, and not running on UDP and IP directly.

When web function is running on the switch and client visit our web site through the internet browser, we can use SSL function. The communication between client and switch through SSL connect can improve the security.

Firstly, SSL should be enabled on the switch. When the client tries to access the switch through https method, a SSL session will be set up between the switch and the client. When the SSL session has been set up, all the data transmission in the application layer will be encrypted.

SSL handshake is done when the SSL session is being set up. The switch should be able to provide certification keys. Currently the keys provided by the switch are not the formal certification keys issued by official authentic, but the private certification keys generated by SSL software under Linux which may not be recognized by the web browser. With regard to the switch application, it is not necessary to apply for a formal SSL certification key. A private certification key is enough to make the communication safe between the users and the switch. Currently it is not required that the client is able to check the validation of the certification key. The encryption key and the encryption method should be negotiated during the handshake period of the session which will be then used for data encryption.

SSL session handshake process:



8.2 SSL Configuration Task List

1. Enable/disable SSL function
2. Configure/delete port number by SSL used
3. Configure/delete secure cipher suite by SSL used
4. Maintenance and diagnose for the SSL function

1. Enable/disable SSL function

Command	Explanation
Global Mode	
ip http secure-server **no ip http secure-server**	Enable/disable SSL function.

2. Configure/delete port number by SSL used

Command	Explanation
Global Mode	
ip http secure-port <*port-number*> **no ip http secure-port**	Configure port number by SSL used, the"**no ip http secure-port**" command deletes the port number.

3. Configure/delete secure cipher suite by SSL used

Command	Explanation
Global Mode	
ip http secure-ciphersuite {des-cbc3-sha|rc4-128-sha| des-cbc-sha} **no ip http secure-ciphersuite**	Configure/delete secure cipher suite by SSL used.

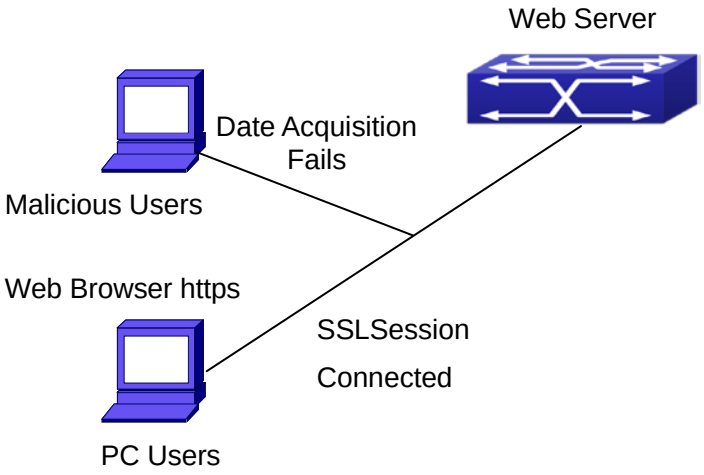
4. Maintenance and diagnose for the SSL function

Command	Explanation
Admin Mode or Configuration Mode	
show ip http secure-server status	Show the configured SSL information.
debug ssl **no debug ssl**	Open/close the DEBUG for SSL function.

8.3 SSL Typical Example

When the Web function is enabled on the switch, SSL can be configured for users to access the web interface on the switch. If the SSL has been configured, communication between the client and the switch will be encrypted through SSL for safety.

Firstly, SSL should be enabled on the switch. When the client tries to access the switch through https method, a SSL session will be set up between the switch and the client. When the SSL session has been set up, all the data transmission in the application layer will be encrypted.



Configuration on the switch:
Switch(config)# ip http secure-server
Switch(config)# ip http secure-port 1025
Switch(config)# ip http secure-ciphersuite rc4-128-sha

8.4 SSL Troubleshooting

In configuring and using SSL, the SSL function may fail due to reasons such as physical connection failure or wrong configurations. The user should ensure the following:

- First good condition of the physical connection;
- Second all interface and link protocols are in the UP state (use “show interface” command);
- Then, make sure SSL function is enabled (use ip http secure-server command);
- Don’t use the default port number if configured port number, pay attention to the port number when input the web wide;
- If SSL is enabled, SSL should be restarted after changes on the port configuration and encryption configuration;
- IE 7.0 or above should be used for use of des-cbc-sha;
- If the SSL problems remain unsolved after above try, please use debug SSL and other debugging command and copy the DEBUG message within 3 minutes, send the recorded message to technical server center of our company.

Chapter 9 IPv6 Security RA Configuration

9.1 Introduction to IPv6 Security RA

In IPv6 networks, the network topology is generally compromised of routers, layer-two switches and IPv6 hosts. Routers usually advertise RA, including link prefix, link MTU and other information, when the IPv6 hosts receive RA, they will create link address, and set the default router as the one sending RA in order to implement IPv6 network communication. If a vicious IPv6 host sends RA to cause that normal IPv6 users set the default router as the vicious IPv6 host user, the vicious user will be able to capture the information of other users, which will threat the network security. Simultaneously, the normal users get incorrect address and will not be able to connect to the network. So, in order to implement the security RA function, configuring on the switch ports to reject vicious RA messages is necessary, thus to prevent forwarding vicious RA to a certain extent and to avoid affecting the normal operation of the network.

9.2 IPv6 Security RA Configuration Task Sequence

1. Globally enable IPv6 security RA
2. Enable IPv6 security RA on a port
3. Display and debug the relative information of IPv6 security RA

1. Globally enable IPv6 security RA

Command	Explanation
Global Configuration Mode	
ipv6 security-ra enable **no ipv6 security-ra enable**	Globally enable and disable IPv6 security RA.

2. Enable IPv6 security RA on a port

Command	Explanation
Port Configuration Mode	
ipv6 security-ra enable **no ipv6 security-ra enable**	Enable and disable IPv6 security RA in port configuration mode.

3. Display and debug the relative information of IPv6 security RA

Command	Explanation
Admin Mode	
debug ipv6 security-ra **no debug ipv6 security-ra**	Enable the debug information of IPv6 security RA module, the no operation of this command will disable the output of debug information of IPv6 security RA.
show ipv6 security-ra [interface *<interface-list>*]	Display the distrust port and whether globally security RA is enabled.

9.3 IPv6 Security RA Typical Examples

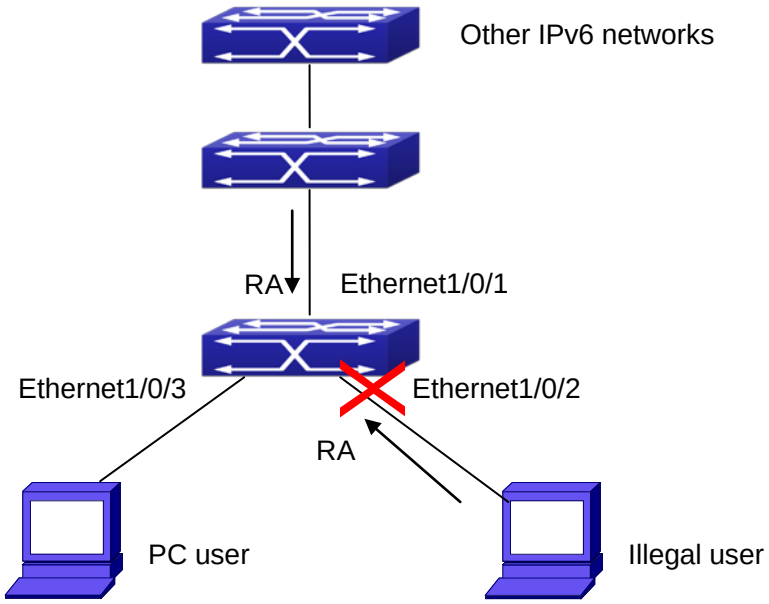


Fig 9-1 IPv6 Security RA sketch map

Instructions: if the illegal user in the graph advertises RA, the normal user will receive the RA, set the default router as the vicious IPv6 host user and change its own address. This will cause the normal user to not be able to connect the network. We want to set security RA on the 1/0/2 port of the switch, so that the RA from the illegal user will not affect the normal user.

Switch configuration task sequence:

Switch#config

Switch(config)#ipv6 security-ra enable

Switch(Config-If-Ethernet1/0/2)# ipv6 security-ra enable

9.4 IPv6 Security RA Troubleshooting Help

The function of IPv6 security RA is quite simple, if the function does not meet the expectation after configuring IPv6 security RA:

- ☞ Check if the switch is correctly configured.
- ☞ Check if there are rules conflicting with security RA function configured on the switch, this kind of rules will cause RA messages to be forwarded.

Chapter 10 VLAN-ACL Configuration

10.1 Introduction to VLAN-ACL

The user can configure ACL policy to VLAN to implement the accessing control of all ports in VLAN, and VLAN-ACL enables the user to expediently manage the network. The user only needs to configure ACL policy in VLAN, the corresponding ACL action can takes effect on all member ports of VLAN, but it does not need to solely configure on each member port.

When VLAN ACL and Port ACL are configured at the same time, the principle of denying firstly is used. When the packets match VLAN ACL and Port ACL at the same time, as long as one rule is drop, then the final action is drop.

Egress ACL can implement the filtering of the packets on egress and ingress direction, the packets match the specific rules can be allowed or denied. ACL can support IP ACL, MAC ACL, MAC-IP ACL, IPv6 ACL. Ingress direction of VLAN can bind four kinds of ACL at the same time, there are four resources on egress direction of VLAN, IP ACL and MAC ACL engage one resource severally, MAC-IP ACL and IPv6 ACL engage two resources severally, so egress direction of VLAN can not bind four kinds of ACL at the same time. When binding three kinds of ACL at the same time, it should be the types of IP, MAC, MAC-IP or IP, MAC, IPv6. When binding two kinds of ACL at the same time, any combination of ACL type is valid. Each type can only apply one on a VLAN.

10.2 VLAN-ACL Configuration Task List

1. Configure VLAN-ACL of IP type
2. Configure VLAN-ACL of MAC type
3. Configure VLAN-ACL of MAC-IP
4. Configure VLAN-ACL of IPv6 type
5. Show configuration and statistic information of VLAN-ACL
6. Clear statistic information of VLAN-ACL

1. Configure VLAN-ACL of IP type

Command	Explanation
Global mode	

vacl ip access-group {<1-299> | WORD} {in | out} [traffic-statistic] vlan WORD **no vacl ip access-group {<1-299> | WORD} {in | out} vlan WORD**	Configure or delete IP VLAN-ACL.

2. Configure VLAN-ACL of MAC type

Command	Explanation
Global mode	
vacl mac access-group {<700-1199> | WORD} {in | out} [traffic-statistic] vlan WORD **no vacl mac access-group {<700-1199> | WORD} {in | out} vlan WORD**	Configure or delete MAC VLAN-ACL.

3. Configure VLAN-ACL of MAC-IP

Command	Explanation
Global mode	
vacl mac-ip access-group {<3100-3299> | WORD} {in | out} [traffic-statistic] vlan WORD **no vacl mac-ip access-group {<3100-3299> | WORD} {in | out} vlan WORD**	Configure or delete MAC-IP VLAN-ACL.

4. Configure VLAN-ACL of IPv6 type

Command	Explanation
Global mode	
vacl ipv6 access-group (<500-699> | WORD) {in | out} (traffic-statistic|) vlan WORD **no ipv6 access-group {<500-699> | WORD} {in | out} vlan WORD**	Configure or delete IPv6 VLAN-ACL.

5. Show configuration and statistic information of VLAN-ACL

Command	Explanation
Admin mode	
show vacl [in | out] vlan [<*vlan-id*>]	Show the configuration and the statistic information of VACL.

6. Clear statistic information of VLAN-ACL

Command	Explanation
Admin mode	
clear vacl [in | out] statistic vlan [<*vlan-id*>]	Clear the statistic information of VACL.

10.3 VLAN-ACL Configuration Example

A company's network configuration is as follows, all departments are divided by different VLANs, technique department is Vlan1, finance department is Vlan2. It is required that technique department can access the outside network at timeout, but finance department are not allowed to access the outside network at any time for the security. Then the following policies are configured:

- ☞ Set the policy VACL_A for technique department. At timeout they can access the outside network, the rule as permit, but other times the rule as deny, and the policy is applied to Vlan1.
- ☞ Set the policy VACL_B of ACL for finance department. At any time they can not access the outside network, but can access the inside network with no limitation, and apply the policy to Vlan2.

Network environment is shown as below:

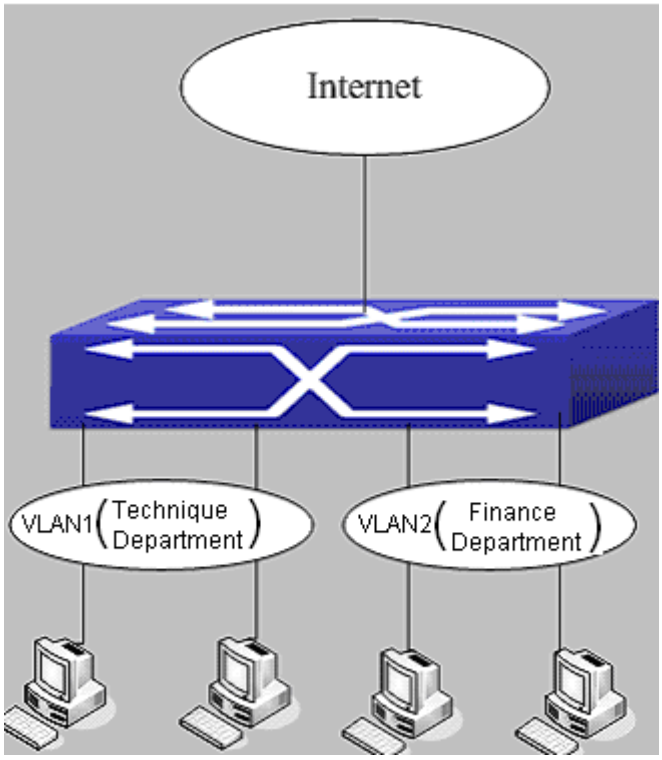


Fig 10-1 VLAN-ACL configuration example

Configuration example:

1) First, configure a timerange, the valid time is the working hours of working day:

Switch(config)#time-range t1

Switch(config-time-range-t1)#periodic weekdays 9:00:00 to 12:00:00

Switch(config-time-range-t1)#periodic weekdays 13:00:00 to 18:00:00

2) Configure the extended acl_a of IP, at working hours it only allows to access the resource within the internal network (such as 192.168.0.255).

Switch(config)# ip access-list extended vacl_a

Switch(config-ip-ext-nacl-vacl_a)# permit ip any-source 192.168.0.0 0.0.0.255 time-range t1

Switch(config-ip-ext-nacl-vacl_a)# deny ip any-source any-destination time-range t1

3) Configure the extended acl_b of IP, at any time it only allows to access resource within the internal network (such as 192.168.1.255).

Switch(config)#ip access-list extended vacl_b

Switch(config-ip-ext-nacl-vacl_a)# permit ip any-source 192.168.1.0 0.0.0.255

Switch(config-ip-ext-nacl-vacl_a)# deny ip any-source any-destination

4) Apply the configuration to VLAN

Switch(config)#vacl ip access-group vacl_a in vlan 1

Switch(config)#vacl ip access-group vacl_b in vlan 2

10.4 VLAN-ACL Troubleshooting

- ☞ When VLAN ACL and Port ACL are configured at the same time, the principle of denying firstly is used. When the packets match VLAN ACL and Port ACL at the same time, as long as one rule is drop, then the final action is drop.
- ☞ Each ACL of different types can only apply one on a VLAN, such as the basic IP ACL, each VLAN can applies one only.

Chapter 11 MAB Configuration

11.1 Introduction to MAB

In actual network existing the device which can not install the authentication client, such as printer, PDA devices, they can not process 802.1x authentication. However, to access the network resources, they need to use MAB authentication to replace 802.1x authentication.

MAB authentication is a network accessing authentication method based on the accessing port and the MAC address of MAB user. The user needn't install any authentication client, after the authentication device receives ARP packets sent by MAB user, it will authenticate the MAC address of the MAB user and there is the corresponding authentication information in the authentication server, the matched packets of the port and the source MAC are allowed to pass when the authentication is successful. MAB user didn't need to input the username and password manually in the process of authentication.

At present, MAB authentication device only supports RADIUS authentication method. There is the selection method for the authentication username and password: use the MAC address of the MAB user as the username and password, or the fixed username and password (all users use the configured username and password to authenticate).

11.2 MAB Configuration Task List

MAB Configuration Task List:

1. Enable MAB function
   1) Enable global MAB function
   2) Enable port MAB function
2. Configure MAB authentication username and password
3. Configure MAB parameters
   1) Configure guest-vlan
   2) Configure the binding-limit of the port
   3) Configure the reauthentication time
   4) Configure the offline detection time
   5) Configure other parameters

1. Enable MAB function

Command	Explanation
Global Mode	
mac-authentication-bypass enable **no mac-authentication-bypass enable**	Enable the global MAB authentication function.
Port Mode	
mac-authentication-bypass enable **no mac-authentication-bypass enable**	Enable the port MAB authentication function.

2. Configure MAB authentication username and password

Command	Explanation
Global Mode	
mac-authentication-bypass username-format {mac-address | {fixed username WORD password WORD}}	Set the authentication mode of MAB authentication function.

3. Configure MAB parameters

Command	Explanation
Port Mode	
mac-authentication-bypass guest-vlan <1-4094> **no mac-authentication-bypass guest-vlan**	Set guset vlan of MAB authentication, only Hybrid port uses this command, it is not take effect on access port.
mac-authentication-bypass binding-limit <1-100> **no mac-authentication-bypass binding-limit**	Set the max MAB binding-limit of the port.
Global Mode	
mac-authentication-bypass timeout reauth-period <1-3600> **no mac-authentication-bypass timeout reauth-period**	Set the reauthentication interval after the authentication is unsuccessful.
mac-authentication-bypass timeout offline-detect （0｜<60-7200>） **no mac-authentication-bypass timeout offline-detect**	Set offline detection interval.

mac-authentication-bypass timeout quiet-period <1-60> **no mac-authentication-bypass timeout quiet-period**	Set quiet-period of MAB authentication.
mac-authentication-bypass timeout stale-period <0-60> **no mac-authentication-bypass timeout stale-period**	Set the time that delete the binding after the port is down.
mac-authentication-bypass timeout linkup-period <0-30> **no mac-authentication-bypass timeout linkup-period**	To obtain IP again, set the interval of down/up when MAB binding is changing into VLAN.
authentication mab {radius|local} (none|) **no authentication mab**	Configure the authentication mode and priority of MAC address, the no command restores the default authentication mode.

11.3 MAB Example

Example:

The typical example of MAB authentication function:

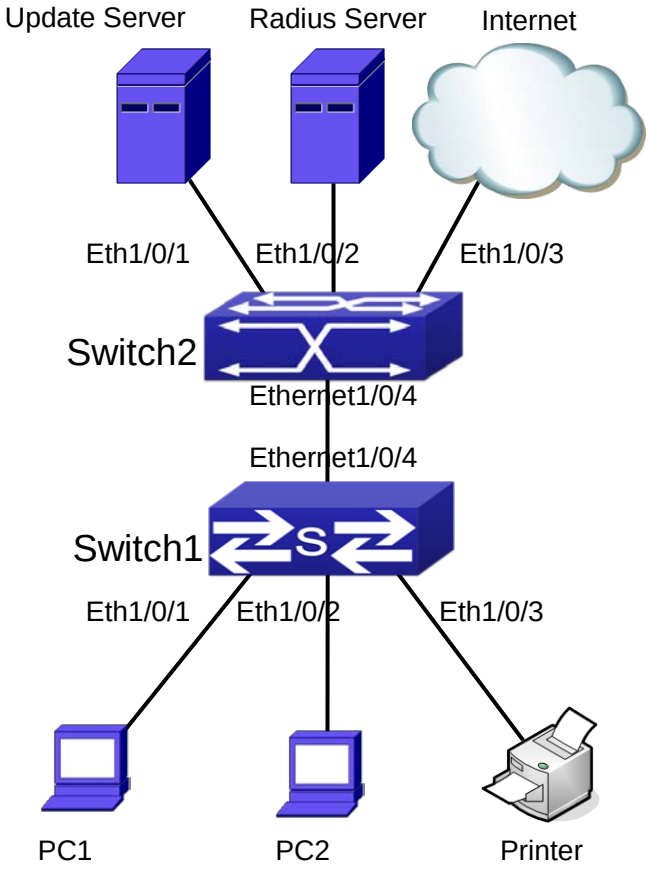


Fig 11-1 MAB application

Switch1 is a layer 2 accessing switch, Switch2 is a layer 3 aggregation switch.

Ethernet 1/0/1 is an access port of Switch1, connects to PC1, it enables 802.1x port-based function and configures guest vlan as vlan8.

Ethernet 1/0/2 is a hybrid port, connects to PC2, native vlan of the port is vlan1, and configures guest vlan as vlan8, it joins in vlan1, vlan8 and vlan10 with untag method and enables MAB function.

Ethernet 1/0/3 is an access port, connects to the printer and enables MAB function.

Ethernet 1/0/4 is a trunk port, connects to Switch2.

Ethernet 1/0/4 is a trunk port of Switch2, connects to Switch1.

Ethernet 1/0/1 is an access port, belongs to vlan8, connects to update server to download and upgrade the client software.

Ethernet 1/0/2 is an access port, belongs to vlan9, connects to radius server which configure auto vlan as vlan10.

Ethernet 1/0/3 is an access port, belongs to vlan10, connects to external internet

resources.

To implement this application, the configuration is as follows:

Switch1 configuration:

(1) Enable 802.1x and MAB authentication function globally, configure username and password of MAB authentication and radius-server address

```
Switch(config)# dot1x enable
Switch(config)# mac-authentication-bypass enable
Switch(config)#mac-authentication-bypass username-format fixed username mabuser password mabpwd
Switch(config)#vlan 8-10
Switch(config)#interface vlan 9
Switch(config-if-vlan9)ip address 192.168.61.9 255.255.255.0
Switch(config-if-vlan9)exit
Switch(config)#radius-server authentication host 192.168.61.10
Switch(config)#radius-server accounting host 192.168.61.10
Switch(config)#radius-server key test
Switch(config)#aaa enable
Switch(config)#aaa-accounting enable
```

(2) Enable the authentication function of each port

```
Switch(config)#interface ethernet 1/0/1
Switch(config-if-ethernet1/0/1)#dot1x enable
Switch(config-if-ethernet1/0/1)#dot1x port-method portbased
Switch(config-if-ethernet1/0/1)#dot1x guest-vlan 8
Switch(config-if-ethernet1/0/1)#exit

Switch(config)#interface ethernet 1/0/2
Switch(config-if-ethernet1/0/2)#switchport mode hybrid
Switch(config-if-ethernet1/0/2)#switchport hybrid native vlan 1
Switch(config-if-ethernet1/0/2)#switchport hybrid allowed vlan 1;8;10 untag
Switch(config-if-ethernet1/0/2)#mac-authentication-bypass enable
Switch(config-if-ethernet1/0/2)#mac-authentication-bypass enable guest-vlan 8
Switch(config-if-ethernet1/0/2)#exit

Switch(config)#interface ethernet 1/0/3
Switch(config-if-ethernet1/0/3)#switchport mode access
Switch(config-if-ethernet1/0/3)#mac-authentication-bypass enable
```

```
Switch(config-if-ethernet1/0/3)#exit

Switch(config)#interface ethernet 1/0/4
Switch(config-if-ethernet1/0/4)# switchport mode trunk
```

11.4 MAB Troubleshooting

If there is any problem happens when using MAB function, please check whether the problem is caused by the following reasons:

- ☞ Make sure global and port MAB function are enabled;
- ☞ Make sure the correct username and password of MAB authentication are used;
- ☞ Make sure the radius-server configuration is correct. Complete MAB offline-detect through query whether dynamic MAC is exist. Do not delete the binding if the MAC address exists in MAC address table. The actual offline time without the traffic is 1-2 MAC aging period add 0-1 MAB offline-detect time.