
Contents

1 Configuring ERPS.....	1
1.1 Introduction.....	1
1.1.1 Overview.....	1
1.1.2 Control VLAN and Data VLAN.....	1
1.1.3 Basic Model of an Ethernet Ring.....	1
1.1.4 RPL and Nodes.....	3
1.1.5 ERPS Packet.....	4
1.1.6 ERPS Timer.....	5
1.1.7 Ring Protection.....	5
1.1.8 Load Balancing.....	6
1.1.9 Protocols and Standards.....	6
1.2 Configuration Task Summary.....	6
1.3 Configuring a Control VLAN for an Ethernet Ring.....	7
1.3.1 Overview.....	7
1.3.2 Restrictions and Guidelines.....	7
1.3.3 Procedure.....	7
1.4 Configuring Member Ports for an Ethernet Ring.....	7
1.4.1 Overview.....	7
1.4.2 Restrictions and Guidelines.....	8
1.4.3 Procedure.....	8
1.5 Configuring an RPL Port.....	9
1.5.1 Overview.....	9

1.5.2 Restrictions and Guidelines.....	9
1.5.3 Procedure.....	9
1.6 Configuring Major Rings to Associate with Subrings.....	10
1.6.1 Overview.....	10
1.6.2 Restrictions and Guidelines.....	10
1.6.3 Procedure.....	10
1.7 Configuring Subring Topology Change Notification.....	10
1.7.1 Overview.....	10
1.7.2 Procedure.....	10
1.8 Configuring a Protected VLAN for an Ethernet Ring.....	11
1.8.1 Overview.....	11
1.8.2 Restrictions and Guidelines.....	11
1.8.3 Procedure.....	11
1.9 Enabling ERPS for an Ethernet Ring.....	12
1.9.1 Overview.....	12
1.9.2 Restrictions and Guidelines.....	12
1.9.3 Procedure.....	12
1.10 Configuring ERPS Timers.....	12
1.10.1 Overview.....	12
1.10.2 Restrictions and Guidelines.....	12
1.10.3 Procedure.....	12
1.11 Enabling ERPS Globally.....	13
1.11.1 Overview.....	13
1.11.2 Procedure.....	13

1.12 Monitoring.....	13
1.13 Configuration Examples.....	14
1.13.1 Configuring Single-Ring Protection.....	14
1.13.2 Configuring Tangent-Ring Protection.....	17
1.13.3 Configuring Intersecting-Ring Protection.....	22
1.13.4 Configuring Load Balancing.....	29
1.13.5 Modifying ERPS Configuration.....	34

1 Configuring ERPS

1.1 Introduction

1.1.1 Overview

Ethernet Ring Protection Switching (ERPS), also known as G.8032, is a ring protection protocol developed by the International Telecommunication Union (ITU). It is a data link layer protocol specially designed for Ethernet rings. ERPS prevents broadcast storms caused by data loops when an Ethernet ring network is intact, and can rapidly perform link switching and recover the communication between nodes when a link is disconnected in the Ethernet ring, so as to implement data link redundancy.

Currently, the Spanning Tree Protocol (STP) is another solution to the L2 network loop problem. STP is at mature application stage but requires a relatively long (within seconds) convergence time. Compared with STP, ERPS provides faster convergence, with the L2 convergence time less than 50 ms.

1.1.2 Control VLAN and Data VLAN

ERPS supports two types of virtual local area networks (VLANs): control VLANs and data VLANs.

- Control VLAN: Also known as the Ring Auto Protection Switching VLAN (R-APS VLAN) for transmitting ERPS protocol packets. On a device, the ports connecting to an ERPS ring belong to a control VLAN, and only such ports can be added to a control VLAN.
- Data VLAN: A data VLAN is used to transmit data packets. Both ERPS ports and non-ERPS ports can be assigned to a data VLAN. A data VLAN is also known as a protected VLAN.

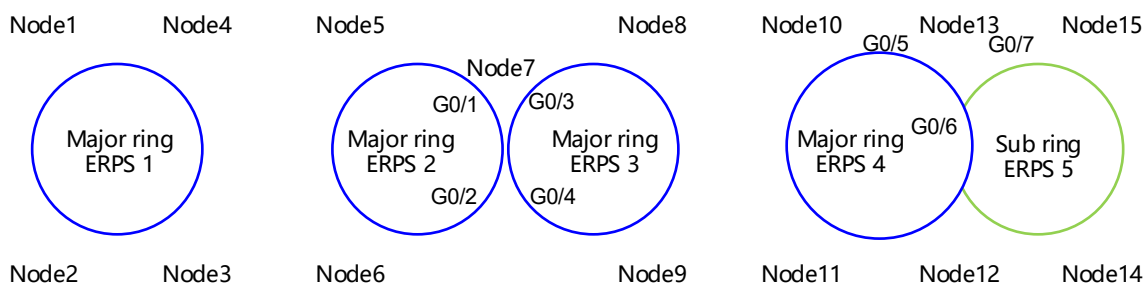
1.1.3 Basic Model of an Ethernet Ring

A group of interconnected devices in the same control VLAN (R-APS VLAN) constitute an Ethernet ring (ERPS ring), in which each device is called a node. ERPS rings can be classified into major rings and subrings based on whether a ring is closed.

1. Major Ring and Subring

- Major ring and major ring link: A major ring is a topology of a closed network connected in a ring, such as the blue rings shown in [Figure 1-1](#). In an ERPS ring, links that belong to and are controlled by a major ring are called major ring links.
- Subring and subring link: A subring is a topology of a non-closed network attached to a major ring, such as the green ring shown in [Figure 1-1](#). In an ERPS ring, links that belong to and are controlled by a subring are called subring links.
- R-APS virtual channel in a subring: A channel used to transmit subring protocol packets in a major ring. It belongs to a major ring rather than a subring. For example, the link between node 12 and node 13 as shown in [Figure 1-1](#) is an R-APS virtual channel.

Figure 1-1 Basic Topologies of Ethernet Rings



2. Basic Topologies

Major rings, subrings, and nodes can form basic topologies with different characteristics, depending on the connection modes, as shown in [Figure 1-1](#).

- Single ring: Major ring ERPS 1 (node 1-2-3-4) constitutes a single-ring topology.
- Tangent rings: A topology in which two ERPS rings share one device is called tangent rings. Major ring ERPS 2 (node 5-6-7) and major ring ERPS 3 (node 7-8-9) constitute a tangent-ring topology, and are tangent to each other on one node, namely, node 7.
- Intersecting rings: A topology in which two ERPS rings share two devices is called intersecting rings. Major ring ERPS 4 (node 13-10-11-12) and subring ERPS 5 (node 13-15-14-12) constitute an intersecting-ring topology, and intersect on two directly connected intersecting nodes, namely, node 13 and node 12.

In practice, a network is a combination of multiple basic topologies, with multiple major rings and multiple subrings.

3. Node

According to the different topological relationships between nodes and Ethernet rings, nodes are classified into single-ring nodes, tangent nodes, and intersecting nodes by role.

- Single-ring node: In an Ethernet ring, the nodes that belong to only one Ethernet ring (either major ring or subring) are called single-ring nodes. Two physical ports need to be provided on a single-ring node so that the node can be added to one ERPS ring. As shown in [Figure 1-1](#), nodes 1-4 in the single-ring topology, nodes 5, 6, 8, and 9 in the tangent-ring topology, and nodes 10, 11, 14, and 15 in the intersecting-ring topology are all single-ring nodes.
- Tangent node: A device shared in tangent rings is called a tangent node. Four physical ports need to be provided on each tangent node, with two added to a major ring and the other two added to another major ring. As shown in [Figure 1-1](#), node 7 in the tangent-ring topology is a tangent node.
- Intersecting node: The nodes in intersecting rings that belong to multiple rings are called intersecting nodes. The intersecting nodes must be connected directly without any other nodes in between. Three physical ports need to be provided on a tangent node, with two added to a major ring and the other added to a subring. As shown in [Figure 1-1](#), nodes 12 and 13 in the intersecting-ring topology are intersecting nodes. ERPS rings can intersect with other multiple ERPS rings and share links to implement data link redundancy. Services can be quickly switched from a failed link in one ERPS ring to a normal link.

4. Ring Member Port

An Ethernet ring has two ring member ports on each node that it passes through: the **west** and **east** ports. As shown in [Figure 1-1](#):

- If an ERPS ring is a closed major ring, each node that the ring passes through has two physical ports used as the **west** and **east** ports for adding the node to the ERPS ring. For example, on node 7, GigabitEthernet 0/1 and 0/2 are added to the major ring ERPS 2, and GigabitEthernet 0/3 and 0/4 are added to the major ring ERPS 3. On node 13, GigabitEthernet 0/5 and 0/6 are added to the major ring ERPS 4.
- If an ERPS ring is a non-closed subring (in an intersecting-ring topology), a non-intersecting node has two physical ports used as the **west** and **east** ports for adding the node to the ERPS subring, such as node 15. On an intersecting node, only one physical port is added to the ERPS subring as a ring member port, and the other ring member port is a virtual channel (indicated by **virtual-channel**). For example, on node 13, only GigabitEthernet 0/7 is added to the subring ERPS 5.

There are two states for a port running the ERPS protocol: forwarding and discarding. Their functions are listed in [Table 1-1](#).

Table 1-1 ERPS Protocol Port States

Port State	Receiving Protocol Packets	Sending Protocol Packets	Address Learning	Receiving Data Packets	Sending Data Packets
Discarding	Yes	Yes	No	No	No
Forwarding	Yes	Yes	Yes	Yes	Yes

1.1.4 RPL and Nodes

An Ethernet ring can be in either of the following two states regardless of whether it is a major ring or subring:

- Idle state: The physical links in the entire ring network are connected.
- Protection state: A physical link in the ring network is disconnected.

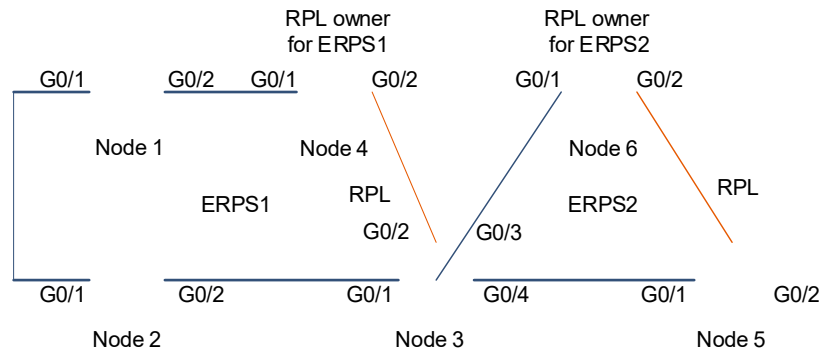
Ring protection link (RPL): When the physical links in a ring network are connected, the ERPS ring is in the idle state, and the links in the logic blocking state are RPLs. Each Ethernet ring has only one RPL. For example, the links indicated by the orange lines shown in [Figure 1-1](#) are RPLs, the link between node 3 and node 4 is the RPL of the Ethernet ring ERPS 1 (node 1-2-3-4), and the link between node 5 and node 6 is the RPL of the Ethernet ring ERPS 2 (node 3-5-6).

A node that is adjacent to an RPL and is used to block the RPL to prevent loops when the Ethernet ring is free of faults is called an RPL owner node. As shown in [Figure 1-1](#), node 4 is the RPL owner node of the Ethernet ring ERPS 1 (node 1-2-3-4) and node 6 is the RPL owner node of the ERPS 2 (node 3-5-6).

Any nodes other than the RPL owner node in an Ethernet ring are non-RPL owner nodes. As shown in [Figure 1-1](#), nodes except node 4 and node 6 are non-RPL owner nodes of the rings.

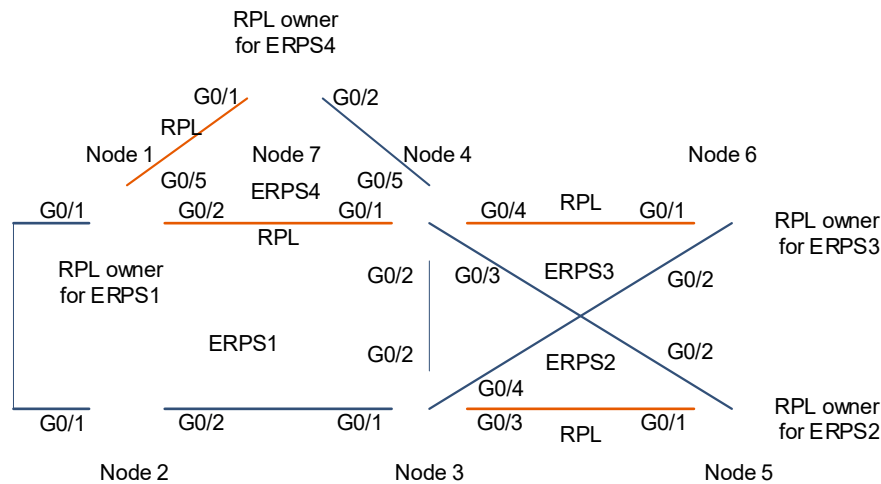
Blocked ports on RPLs are RPL ports, and RPL ports do not forward data packets to prevent loops. RPL ports are on RPL owner nodes, and the RPL owner nodes block the RPL ports. Each Ethernet ring has only one RPL owner node.

Figure 1-1 Typical Topology of Tangent Rings



As shown in [Figure 1-1](#), the link between node 3 and node 4 is the RPL of the Ethernet ring ERPS 1. As the RPL owner node of ERPS 1, node 4 blocks the RPL port. The link between node 5 and node 6 is the RPL of the Ethernet ring ERPS 2. As the RPL owner node of ERPS 2, node 6 blocks the RPL port. ERPS 1 (node 1-2-3-4) and ERPS 2 (node 3-5-6) share node 3, forming a tangent-ring topology. Node 3 is the tangent node.

Figure 1-2 Typical Topology of Intersecting Rings



As shown in [Figure 1-2](#), ERPS 1 (node 1-2-3-4) is a major ring, and ERPS 2 (node 3-4-5) is a subring. ERPS 1 and ERPS 2 share node 3 and node 4, forming an intersecting-ring topology. The links between node 4 and node 5, and between node 3 and node 5 are links of the subring ERPS 2 and are controlled by ERPS 2. The link between node 3 and node 4 belongs to the major ring not the subring, and is not controlled by the subring. However, the protocol packets of the subring are transmitted through the direct link between node 3 and node 4. This direct link is the R-APS virtual channel of the subring ERPS 2. Node 2 only belongs to the major ring ERPS 1, and is called a single-ring node. Node 6 only belongs to the subring ERPS 3, and is also called a single-ring node. Node 3 and node 4 are tangent nodes.

1.1.5 ERPS Packet

ERPS packets (also called R-APS packets) are classified into Signal Fail (SF) packets, No Request (NR) packets, No Requests-RPL Blocked (NR-RB) packets, and Flush packets.

- SF packet: When the link of a node is down, the node sends an SF packet to notify other nodes of its link

failure.

- NR packet: When the failed link is restored, the node sends an NR packet to notify the RPL owner node of its link recovery.
- NR-RB packet: When all nodes in an ERPS ring function properly, the RPL owner node sends NR-RB packets periodically.
- Flush packet: In intersecting rings, when a topology change occurs in a subring, the intersecting nodes send flush packets to notify other devices in the Ethernet ring to which the subring is connected.

1.1.6 ERPS Timer

ERPS supports three timers: Holdoff timer, Guard timer, and Wait-To-Restore (WTR) timer.

- Holdoff timer: The timer is used to minimize frequent ERPS topology switching due to intermittent link failures. After you configure the Holdoff timer, ERPS performs topology switching only if the link failure still persists after the timer times out.
- Guard timer: The timer is used to prevent a device from receiving expired R-APS PMDU packets. When a device detects that a link failure is cleared, it sends link recovery packets and starts the Guard timer. Before the timer expires, all packets except Flush packets indicating a subring topology change will be discarded.
- WTR timer: The timer is effective only for RPL owner nodes. It is used to avoid ring status misjudgment by the RPL owner node. When an RPL owner node detects that a failure is cleared, it will not perform topology switching immediately but only if the Ethernet ring is recovered after the WTR timer times out. If a ring failure is detected again before the timer expires, the RPL owner node cancels the timer and does not perform topology switching.

1.1.7 Ring Protection

The ring protection function prevents broadcast storms caused by data loops and can rapidly recover the communication between nodes when a link is disconnected in the Ethernet ring.

- Normal state
 - All nodes in the physical topology are connected in ring mode.
 - ERPS blocks the RPL to prevent loops.
 - ERPS detects failures on each link between adjacent nodes.
- Link fault
 - A node adjacent to a failed node detects the fault.
 - The node adjacent to the failed link blocks the failed link and sends SF packets to notify other nodes in the same ring.
 - An SF packet triggers the RPL owner node to enable the RPL port, and also triggers all nodes to update their MAC address entries and ARP/ND entries and enter the protection state.
- Link recovery
 - When a failed link is restored, an adjacent node still blocks the link and sends NR packets indicating that no local fault exists.
 - When the RPL owner node receives the first NR packet, it starts the WTR timer.
 - When the WTR timer times out, the RPL owner node blocks the RPL and sends an NR-RB packet.

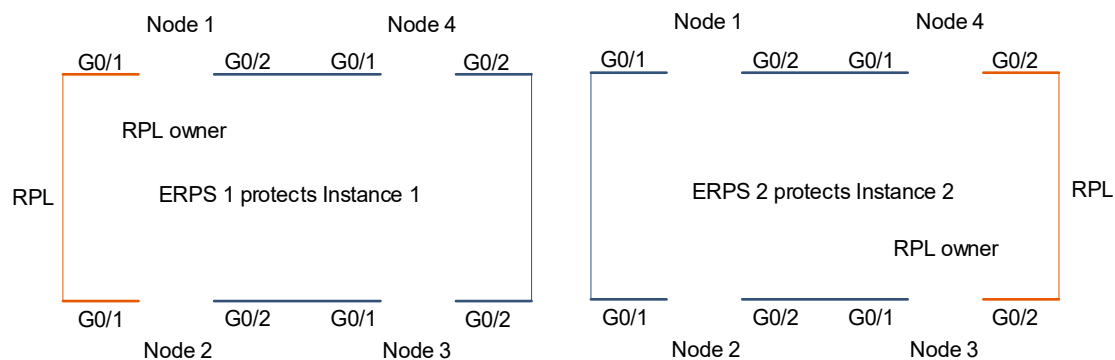
- After receiving this NR-RB packet, other nodes update their MAC address entries and ARP/ND entries, and the node that sends the NR packet stops sending the NR packet and enables the blocked ports.
- The ring network is restored to the normal state.

1.1.8 Load Balancing

One control VLAN identifies one ERPS ring and corresponds to the data VLANs that it needs to protect. By default, an ERPS ring protects all VLANs. You do not need to configure the VLANs to be protected by an Ethernet ring.

If multiple control VLANs are configured in the same physical ring network to form multiple Ethernet rings and they need to protect different data VLANs, load balancing can be achieved. In this case, the traffic from different VLANs is forwarded along their respective paths. When a link in the ring network with load balancing enabled fails, the traffic can be quickly switched to a normal link.

Figure 1-1 Typical Application of Load Balancing



As shown in [Figure 1-1](#), two Ethernet rings (ERPS 1 and ERPS 2) are configured on the physical ring network to protect different VLANs. Node 1 is the RPL owner of ERPS 1, and node 3 is the RPL owner of ERPS 2. With such configurations, data of different VLANs can be transmitted by different links to achieve load balancing.

1.1.9 Protocols and Standards

ITU-T G.8032/Y.1344: Ethernet ring protection switching

1.2 Configuration Task Summary

The configuration includes the following tasks:

- (1) [Configuring a Control VLAN for an Ethernet Ring](#)
- (2) [Configuring Member Ports for an Ethernet Ring](#)
- (3) (Optional) [Configuring an RPL Port](#)
- (4) (Optional) [Configuring Major Rings to Associate with Subrings](#)
- (5) (Optional) [Configuring Subring Topology Change Notification](#)
- (6) (Optional) [Configuring a Protected VLAN for an Ethernet Ring](#)
- (7) [Enabling ERPS for an Ethernet Ring](#)

- (8) (Optional) [Configuring ERPS Timers](#)
- (9) [Enabling ERPS Globally](#)

1.3 Configuring a Control VLAN for an Ethernet Ring

1.3.1 Overview

A control VLAN, also known as an R-APS VLAN, is used to transmit ERPS protocol packets. A group of interconnected devices in the same control VLAN constitute an Ethernet ring (ERPS ring). For an ERPS ring, the same Ethernet ring R-APS VLAN needs to be configured on each node that it passes through. In practice, one or more ERPS rings may pass through a node, and one control VLAN needs to be configured for each ERPS ring on the node.

- As shown in [Figure 1-1](#), ERPS 1 (node 1-2-3-4) is tangent to ERPS 2 (node 3-5-6) on node 3, on which two ERPS control VLANs need to be created.
- As shown in [Figure 1-2](#), the major ring ERPS 1 (node 1-2-3-4) intersects the subring ERPS 2 (node 3-4-5) on node 3, and the major ring ERPS 1 (node 1-2-3-4) also intersects the subring ERPS 3 (node 3-4-6) on node 3, on which three ERPS control VLANs need to be created.
- As shown in [Figure 1-2](#), only the major ring ERPS 1 (node 1-2-3-4) passes through node 2, on which only one ERPS control VLAN needs to be created. Only the subring ERPS 2 (node 3-4-5) passes through node 5, on which only one ERPS control VLAN needs to be created.

1.3.2 Restrictions and Guidelines

- An R-APS VLAN must be an unused VLAN on a device. VLAN 1 cannot be configured as an R-APS VLAN.
- The packets of different ERPS rings are distinguished using the control VLANs (R-APS VLANs). Therefore, the control VLANs of different ERPS rings must be different.
- If a device with ERPS disabled needs to transparently transmit ERPS packets, ensure that only the two ports connecting the device to an ERPS ring allow packets from the control VLAN of the ERPS ring to pass through. Otherwise, packets from other VLANs may be transparently transmitted to the R-APS VLAN, causing impact on the ERPS ring.

1.3.3 Procedure

- (1) Enter the privileged EXEC mode.
enable
 - (2) Enter the global configuration mode.
configure terminal
 - (3) Create a control VLAN for an Ethernet ring.
erps raps-vlan *vlan-id*
- No R-APS VLAN is configured by default.

1.4 Configuring Member Ports for an Ethernet Ring

1.4.1 Overview

An Ethernet ring has two ring member ports on each node that it passes through: the **west** and **east** ports.

If an ERPS ring is a closed major ring, each node that the ring passes through has two physical ports used as the **west** and **east** ports for adding the node to the ERPS ring. If an ERPS ring is a non-closed subring, a non-intersecting node has two physical ports used as the **west** and **east** ports for adding the node to the ERPS subring. On an intersecting node, only one physical port is added to the ERPS subring as a ring member port, and the other ring member port is a virtual channel (indicated by **virtual channel**).

According to the type of an ERPS ring (major ring or subring), add a physical port or virtual channel of a node to the control VLAN of an ERPS ring so that the port becomes a member port.

1.4.2 Restrictions and Guidelines

- If an Ethernet ring (major or subring) passes through two physical ports on a node, run the **ring-port west interface-type interface-number-1 east interface-type interface-number-2** command to add the two physical ports to the Ethernet ring.
- If an Ethernet ring (subring only) passes through one physical port on a node, run the **ring-port west interface-type interface-number east virtual-channel** command to configure the physical port as the west port of the Ethernet ring, or run the **ring-port west virtual-channel east interface-type interface-number** command to configure the physical port as the east port of the Ethernet ring.
- Only trunk ports can be added to an ERPS ring. The trunk attributes of a port cannot be modified after it is added to an ERPS ring. To modify the trunk attributes, enter the control VLAN configuration mode (that is, R-APS VLAN configuration mode), and run the **no ring-port** command to delete the port from the ERPS ring.
- The ports added to an ERPS ring will not participate in the spanning tree calculation no matter whether the ERPS ring is enabled. When you configure an ERPS ring, ensure that loops do not exist on the member ports of the ring.
- In R-APS VLAN configuration mode, configure the ports that form an ERPS ring as ERPS ring ports.
- ERPS cannot share ports with the Rapid Ethernet Ring Protection (RERP) and Rapid Ethernet Uplink Protection (REUP).
- Do not configure IP address on the ring member ports; otherwise ERPS may be abnormal.
- When an ERPS ring topology changes and a port needs to be modified, to avoid loops during configuration modification, do as follows in sequence: Run the **shutdown** command to shut down one ERPS port in this ring. Enter the control VLAN configuration mode and run the **no state enable** command to disable the ERPS function. Run the **no ring-port** command to delete the ring member port. Finally, add a new member port to the Ethernet ring and run the **state enable** command to enable the ERPS function for the Ethernet ring. Upon completion of configuration, run the **no shutdown** command to enable the port.

1.4.3 Procedure

(1) Configure physical ports as trunk ports.

- a Enter the privileged EXEC mode.

enable

- b Enter the global configuration mode.

configure terminal

- c Enter the interface configuration mode of the ring member ports.

interface { *interface-type interface-number* | **range** *interface-type interface-range* }

- d Set the links of the ring member ports to work in trunk mode.

switchport mode trunk

An interface link works in access mode by default.

- e Return to the global configuration mode.

exit

- (2) Enter the R-APS VLAN configuration mode of an Ethernet ring.

erps raps-vlan *vlan-id*

- (3) Configure the member ports for the Ethernet ring.

ring-port west { *interface-type interface-number* | **virtual-channel** } **east** { *interface-type interface-number* | **virtual-channel** }

No member port exists in an ERPS ring by default.

1.5 Configuring an RPL Port

1.5.1 Overview

Each ERPS ring has only one RPL and only one RPL owner node. Blocked ports on RPLs are RPL ports, which do not forward data packets to prevent loops.

On an ERPS ring, select a device as the RPL owner, enter the R-APS VLAN configuration mode of the Ethernet ring on this device, and configure the west or east port as an RPL port. For non-RPL owner nodes, no RPL port needs to be configured.

1.5.2 Restrictions and Guidelines

- The **west** parameter indicates that the west port is specified as an RPL port, and the **east** parameter indicates that the east port is specified as an RPL port.
- Two tangent rings have two RPLs and two RPL owner nodes. However, do not configure a tangent node as an RPL owner node.

1.5.3 Procedure

- (1) Enter the privileged EXEC mode.

enable

- (2) Enter the global configuration mode.

configure terminal

- (3) Enter the R-APS VLAN configuration mode of an Ethernet ring.

erps raps-vlan *vlan-id*

- (4) Configure an RPL port on an RPL owner node.

```
rpl-port { west | east } rpl-owner
```

No RPL port exists in an ERPS ring by default.

1.6 Configuring Major Rings to Associate with Subrings

1.6.1 Overview

When there are intersecting rings in an Ethernet ring topology, the major ring needs to be configured to associate with all subrings on all nodes in the major ring (no matter whether the subrings are directly connected to the nodes) so that the ERPS packets of subrings can be transmitted in the major ring. The association of major rings with subrings does not need to be configured on nodes only in subrings.

1.6.2 Restrictions and Guidelines

- On all nodes in a major ring of intersecting rings, including intersecting nodes and non-intersecting nodes, the association of the major ring with all subrings needs to be configured so that the ERPS packets of the subrings can be transmitted in the major ring.
- You can also use the command provided by the VLAN module to configure a control VLAN and its member ports so that ERPS packets of subrings can be transmitted in other Ethernet rings and are not leaked to user networks.
- If the subring topology change notification has been configured in a subring of intersecting rings and the link between intersecting nodes is faulty or blocked in the event of a subring topology change, the intersecting nodes will send packets to instruct the nodes in other Ethernet rings associated with the subring to update the topology.

1.6.3 Procedure

- (1) Enter the privileged EXEC mode.

```
enable
```

- (2) Enter the global configuration mode.

```
configure terminal
```

- (3) Enter the control VLAN configuration mode of a major ring.

```
erps raps-vlan vlan-id
```

- (4) Associate the major ring with all subrings.

```
associate sub-ring raps-vlan vlan-list
```

An ERPS major ring is not associated with any subrings by default.

1.7 Configuring Subring Topology Change Notification

1.7.1 Overview

This function is required only in the subrings on intersecting nodes. When the subring topology changes, the intersecting nodes send a topology change notification.

1.7.2 Procedure

- (1) Enter the privileged EXEC mode.

enable

- (2) Enter the global configuration mode.

configure terminal

- (3) Enter the control VLAN configuration mode of a subring.

erps raps-vlan *vlan-id*

- (4) Enable the subring topology change notification.

sub-ring tc-propagation enable

1.8 Configuring a Protected VLAN for an Ethernet Ring

1.8.1 Overview

This section describes how to configure the data VLANs to be protected by an ERPS ring. All VLANs are protected by an ERPS ring by default. When load balancing is needed, multiple Ethernet rings can be configured on the same physical ring network, and different Ethernet rings protect different VLANs. In this way, different Ethernet rings send traffic from different VLANs separately, achieving load balancing. When a link in a ring network with load balancing enabled fails, the traffic can be quickly switched to a normal link.

1.8.2 Restrictions and Guidelines

- Before you configure load balancing, configure the mapping between VLANs and instances in MST configuration mode.
- When you configure load balancing, add all data VLANs of the devices to the ERPS protected VLAN list; otherwise, any unprotected VLAN may cause loops.
- Configure protected VLANs for an Ethernet ring in global configuration mode after you complete the single-ring configuration.

1.8.3 Procedure

- (1) Configure the mapping between instances and VLANs.

- a Enter the privileged EXEC mode.

enable

- b Enter the global configuration mode.

configure terminal

- c Enter the MST configuration mode.

spanning-tree mst configuration

- d Add a VLAN group to an MST instance.

instance *instance-id* vlan *vlan-range*

- e Return to the global configuration mode.

exit

- (2) Enter the control VLAN configuration mode of an Ethernet ring.

erps raps-vlan *vlan-id*

- (3) Configure the Ethernet ring to protect the defined instance so as to protect the specified data VLANs.

protected-instance *instance-id-list*

An Ethernet ring protects all VLANs by default.

1.9 Enabling ERPS for an Ethernet Ring

1.9.1 Overview

This section describes how to enter the R-APS VLAN configuration mode of a specified Ethernet ring, and enable the ERPS function for this Ethernet ring. If more than one Ethernet ring passes through a node, the ERPS function of each Ethernet ring needs to be enabled separately.

1.9.2 Restrictions and Guidelines

ERPS takes effect only after ERPS is enabled both globally and for a specified ring on each node that the Ethernet ring passes through.

1.9.3 Procedure

- (1) Enter the privileged EXEC mode.

enable

- (2) Enter the global configuration mode.

configure terminal

- (3) Enter the R-APS VLAN configuration mode of an Ethernet ring.

erps raps-vlan *vlan-id*

No R-APS VLAN is configured by default.

- (4) Enable the ERPS function of the Ethernet ring.

state enable

The ERPS function of an Ethernet ring is disabled by default.

1.10 Configuring ERPS Timers

1.10.1 Overview

This section describes how to configure the Holdoff, Guard, and WTR timers.

1.10.2 Restrictions and Guidelines

- Run the **timer holdoff-time** command to configure the Holdoff timer. *interval1* indicates the value of the Holdoff timer, in 100 milliseconds. The value range is from 0 to 100, and the default value is **0**.
- Run the **timer guard-time** command to configure the Guard timer. *interval2* indicates the value of the Guard timer, in 10 milliseconds. The value range is from 1 to 200, and the default value is **50**.
- Run the **timer wtr-time** command to configure the WTR timer. *interval3* indicates the value of the WTR timer, in minutes. The value range is from 1 to 12, and the default value is **2**.

1.10.3 Procedure

- (1) Enter the privileged EXEC mode.

enable

- (2) Enter the global configuration mode.

configure terminal

- (3) Enter the control VLAN configuration mode.

erps raps-vlan *vlan-id*

- (4) Configure a timer.

timer { holdoff-time *interval1* | guard-time *interval2* | wtr-time *interval3* }

1.11 Enabling ERPS Globally

1.11.1 Overview

After completing all configurations of the ERPS function, you need to enable ERPS globally on each node that an Ethernet ring passes through so that ERPS takes effect.

1.11.2 Procedure

- (1) Enter the privileged EXEC mode.

enable

- (2) Enter the global configuration mode.

configure terminal

- (3) Enable the global ERPS function.

erps enable

The global ERPS function is disabled by default.

1.12 Monitoring

Run the **show** commands to check the running status of a configured function to verify the configuration effect.

Run the **debug** commands to output debugging information.

Caution

The output debugging information occupies system resources. Therefore, disable the debugging function immediately after use.

Run the **clear** commands to clear information.

Caution

Running the **clear** commands may lose vital information and thus interrupt services.

Table 1-1 Monitoring

Command	Purpose
show erps [global raps_vlan <i>vlan-id</i> [Displays the ERPS configuration and state of a device.


```
sub_ring ]]
```

1.13 Configuration Examples

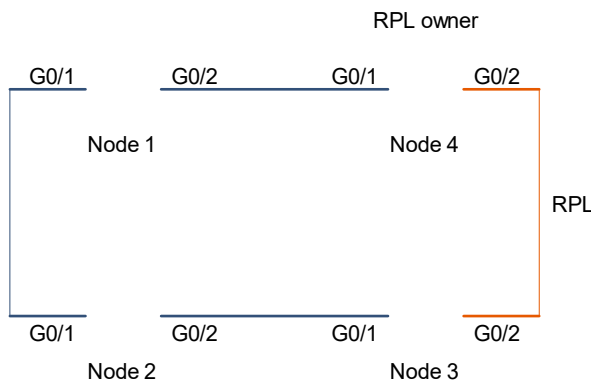
1.13.1 Configuring Single-Ring Protection

1. Requirements

As shown in [Figure 1-1](#), there is only one ring in the network topology. All nodes are connected in a ring in the physical topology. ERPS blocks the RPL to prevent loops, and detects faults on each link between adjacent nodes. There is only one RPL owner node and only one RPL in an Ethernet ring. All nodes must belong to the same R-APS VLAN. All devices in the ring network must support ERPS. Each link between devices must be a direct link without any intermediate device.

2. Topology

Figure 1-1 Application Scenario of Single-Ring Protection



3. Notes

- Before adding a physical port to an Ethernet ring, configure the link of the member port to work in trunk mode.
- Node 1, node 2, and node 3 are all non-RPL owner nodes, through which only ERPS 1 passes. Notes for configuring these nodes are as follows:
 - Configure R-APS VLAN 100, add physical ports GigabitEthernet 0/1 and 0/2 to the Ethernet ring, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.
- Only ERPS 1 passes through node 4 and node 4 is the RPL owner node of the ERPS ring. Notes for configuring this node are as follows:
 - Configure R-APS VLAN 100, add physical ports GigabitEthernet 0/1 and 0/2 to the Ethernet ring, configure GigabitEthernet 0/2 as an RPL port, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.

4. Procedure

- (1) Configure single-ring nodes (node 1, node 2, and node 3) in the same way. The following uses node 1 as an example.

Configure the links of the member ports to work in trunk mode.

```
Node1> enable
Node1# configure terminal
Node1(config)# interface range gigabitethernet 0/1-2
Node1(config-if-rang)# switchport
Node1(config-if-rang)# switchport mode trunk
Node1(config-if-rang)# exit
```

Create an Ethernet ring control VLAN, that is, R-APS VLAN 100.

```
Node1(config)# erps raps-vlan 100
```

Add the two physical ports GigabitEthernet 0/1 and 0/2 to the Ethernet ring.

```
Node1(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
```

Enable the ERPS function for the Ethernet ring.

```
Node1(config-erps 100)# state enable
Node1(config-erps 100)# exit
```

Enable the global ERPS function.

```
Node1(config)# erps enable
```

- (2) Configure node 4 that is a single-ring node and an RPL owner node.

Configure the links of the member ports to work in trunk mode.

```
Node4> enable
Node4# configure terminal
Node4(config)# interface range gigabitethernet 0/1-2
Node4(config-if-rang)# switchport
Node4(config-if-range)# switchport mode trunk
Node4(config-if-range)# exit
```

Create an Ethernet ring control VLAN, that is, R-APS VLAN 100.

```
Node4(config)# erps raps-vlan 100
```

Add the two physical ports GigabitEthernet 0/1 and 0/2 to the Ethernet ring.

```
Node4(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
```

Configure GigabitEthernet 0/2 (east) as the RPL port of R-APS VLAN 100.

```
Node4(config-erps 100)# rpl-port east rpl-Owner
```

Enable the ERPS function for the Ethernet ring.

```
Node4(config-erps 100)# state enable
Node4(config-erps 100)# exit
```

Enable the global ERPS function.

```
Node4(config)# erps enable
```

5. Verification

- (1) Verify the configurations of non-RPL owner nodes: node 1, node 2, and node 3. These three nodes use the same configurations. The following uses node 1 as an example.

```
Node1# show erps
ERPS Information
Global Status           : Enabled
Link monitored by      : Not Oam
-----
R-APS VLAN              : 100
Ring Status            : Enabled
West Port              : Gi0/1      (Forwarding)
East Port              : Gi0/2      (Forwarding)
RPL Port               : None
Protected VLANs       : ALL
RPL Owner              : Disabled
Holdoff Time           : 0 milliseconds
Guard Time            : 500 milliseconds
WTR Time              : 2 minutes
Current Ring State     : idle
Associate R-APS VLAN   :
```

- (2) Verify the configurations of node 4, an RPL owner node.

```
Node4# show erps
ERPS Information
Global Status           : Enabled
Link monitored by      : Not Oam
-----
R-APS VLAN              : 100
Ring Status            : Enabled
West Port              : Gi0/1      (Forwarding)
East Port              : Gi0/2      (Blocking)
RPL Port               : East Port
Protected VLANs       : ALL
RPL Owner              : Enabled
Holdoff Time           : 0 milliseconds
Guard Time            : 500 milliseconds
WTR Time              : 2 minutes
Current Ring State     : idle
Associate R-APS VLAN   :
```

6. Configuration Files

- Configuration files for node 1, node 2, and node 3

```
erps enable
!
erps raps-vlan 100
ring-port west GigabitEthernet 0/1 east GigabitEthernet 0/2
```

```
state enable
!
interface GigabitEthernet 0/1
  switchport mode trunk
!
interface GigabitEthernet 0/2
  switchport mode trunk
```

- Configuration file for node 4

```
erps enable
!
erps raps-vlan 100
  ring-port west GigabitEthernet 0/1 east GigabitEthernet 0/2
  rpl-port east rpl-Owner
  state enable
!
interface GigabitEthernet 0/1
  switchport mode trunk
!
interface GigabitEthernet 0/2
  switchport mode trunk
```

7. Common Errors

- Different R-APS VLANs are configured for the nodes in one ring.
- The ERPS function is not enabled globally and for an Ethernet ring on all nodes in the Ethernet ring. As a result, the ERPS function does not take effect.
- Multiple RPL owner nodes are configured in one ring.
- If member ports on an RPL owner node in an Ethernet ring are modified, the configuration of the RPL port will be deleted by the system. The RPL owner node may fail to operate properly if the RPL port is not configured again.

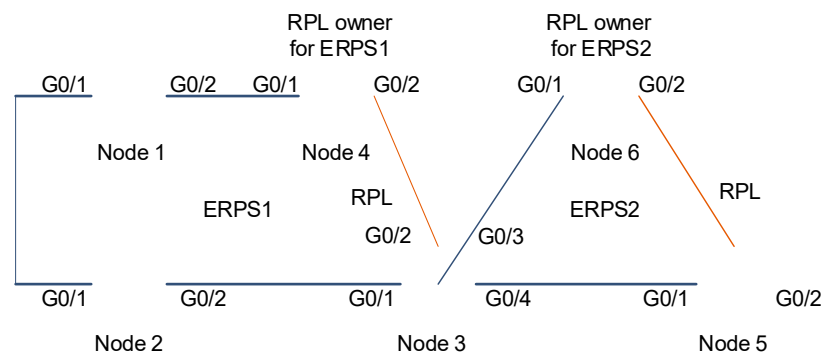
1.13.2 Configuring Tangent-Ring Protection

1. Requirements

In the network topology shown in [Figure 1-1](#), two ring networks share the same device to implement ERPS protection. ERPS is used to detect faults on each link between adjacent nodes. All nodes are connected in a ring in a physical topology. ERPS blocks the RPL of each ring to prevent loops. Each ring has only one RPL owner node and only one RPL. Different rings belong to different R-APS VLANs. All devices in the ring network must support ERPS. Each link between devices must be a direct link without any intermediate device.

2. Topology

Figure 1-1 Application Scenario of Tangent-Ring Protection



3. Notes

- Before adding a physical port to an Ethernet ring, configure the link of the member port to work in trunk mode.
- Node 1 and node 2 are non-RPL owner nodes, through which only ERPS 1 passes. Notes for configuring these nodes are as follows:
 - Configure R-APS VLAN 100, add GigabitEthernet 0/1 and 0/2 to the Ethernet ring, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.
- Node 3 is the tangent node of ERPS 1 and ERPS 2. Notes for configuring this node are as follows:
 - Configure R-APS VLAN 100, add GigabitEthernet 0/1 and 0/2 to R-APS VLAN 100, and enable the ERPS function for the Ethernet ring.
 - Configure R-APS VLAN 200, add GigabitEthernet 0/3 and 0/4 to R-APS VLAN 200, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.
- Only ERPS 1 passes through node 4 and node 4 is the RPL owner node of ERPS 1. Notes for configuring this node are as follows:
 - Configure R-APS VLAN 100, add GigabitEthernet 0/1 and 0/2 to the Ethernet ring, configure GigabitEthernet 0/2 as an RPL port, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.
- Only ERPS 2 passes through node 5 and node 5 is a non-RPL owner node. Notes for configuring this node are as follows:
 - Configure R-APS VLAN 200, add GigabitEthernet 0/1 and 0/2 to the Ethernet ring, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.
- Only ERPS 2 passes through node 6 and node 6 is the RPL owner node of ERPS 2. Notes for configuring this node are as follows:
 - Configure R-APS VLAN 200, add GigabitEthernet 0/1 and 0/2 to the Ethernet ring, configure

GigabitEthernet 0/2 as an RPL port, and enable the ERPS function for the Ethernet ring.

- o Enable the global ERPS function.

4. Procedure

- (1) Configure single-ring nodes (node 1 and node 2) of ERPS 1 in the same way. The following uses node 1 as an example.

Configure the links of Ethernet ring ports GigabitEthernet 0/1 and 0/2 of ERPS 1 to work in trunk mode. Create the Ethernet ring R-APS VLAN 100, add physical ports to the Ethernet ring, and enable the ERPS function for the Ethernet ring.

```
Node1> enable
Node1# configure terminal
Node1(config)# interface range gigabitethernet 0/1-2
Node1(config-if-range)# switchport mode trunk
Node1(config-if-range)# exit
Node1(config)# erps raps-vlan 100
Node1(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node1(config-erps 100)# state enable
Node1(config-erps 100)# exit
```

Enable the global ERPS function.

```
Node1(config)# erps enable
```

- (2) Configure the tangent node: node 3.

Configure the links of Ethernet ring ports GigabitEthernet 0/1 and 0/2 of ERPS 1 to work in trunk mode. Create the Ethernet ring R-APS VLAN 100, add physical ports to the Ethernet ring, and enable the ERPS function for the Ethernet ring.

```
Node3> enable
Node3# configure terminal
Node3(config)# interface range gigabitethernet 0/1-2
Node3(config-if-range)# switchport mode trunk
Node3(config-if-range)# exit
Node3(config)# erps raps-vlan 100
Node3(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node3(config-erps 100)# state enable
Node3(config-erps 100)# exit
```

Configure the links of Ethernet ring ports GigabitEthernet 0/3 and GigabitEthernet 0/4 of ERPS 2 to work in trunk mode. Create the Ethernet ring R-APS VLAN 200, add physical ports to the Ethernet ring, and enable the ERPS function for the Ethernet ring.

```
Node3(config)# interface range gigabitethernet 0/3-4
Node3(config-if-range)# switchport mode trunk
Node3(config-if-range)# exit
Node3(config)# erps raps-vlan 200
```

```
Node3(config-erps 200)# ring-port west gigabitethernet 0/3 east
gigabitethernet 0/4
Node3(config-erps 200)# state enable
Node3(config-erps 200)# exit
```

Enable the global ERPS function.

```
Node3(config)# erps enable
```

- (3) Configure node 4 that is a single-ring node and an RPL owner node of ERPS 1.

Configure the links of Ethernet ring ports GigabitEthernet 0/1 and 0/2 of ERPS 1 to work in trunk mode. Create Ethernet ring R-APS VLAN 100 and add physical ports to the Ethernet ring. Specify the RPL owner port and enable the ERPS function for the Ethernet ring.

```
Node4> enable
Node4# configure terminal
Node4(config)# interface gigabitethernet 0/1
Node4(config-if-GigabitEthernet 0/1)# switchport mode trunk
Node4(config-if-GigabitEthernet 0/1)# exit
Node4(config)# interface gigabitethernet 0/2
Node4(config-if-GigabitEthernet 0/2)# switchport mode trunk
Node4(config-if-GigabitEthernet 0/2)# exit
Node4(config)# erps raps-vlan 100
Node4(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node4(config-erps 100)# rpl-port east rpl-owner
Node4(config-erps 100)# state enable
Node4(config-erps 100)# exit
```

Enable the global ERPS function.

```
Node4(config)# erps enable
```

- (4) Configure the single-ring node (node 5) of ERPS 2.

Configure the links of Ethernet ring ports GigabitEthernet 0/1 and GigabitEthernet 0/2 of ERPS 2 to work in trunk mode. Create Ethernet ring R-APS VLAN 200, add physical ports to the Ethernet ring, and enable the ERPS function for the Ethernet ring.

```
Node5> enable
Node5# configure terminal
Node5(config)# interface gigabitethernet 0/1
Node5(config-if-GigabitEthernet 0/1)# switchport mode trunk
Node5(config-if-GigabitEthernet 0/1)# exit
Node5(config)# interface gigabitethernet 0/2
Node5(config-if-GigabitEthernet 0/2)# switchport mode trunk
Node5(config-if-GigabitEthernet 0/2)# exit
Node5(config)# erps raps-vlan 200
Node5(config-erps 200)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node5(config-erps 200)# state enable
Node5(config-erps 200)# exit
```

Enable the global ERPS function.

```
Node5(config)# erps enable
```

- (5) Configure node 6 that is a single-ring node and an RPL owner node of ERPS 2.

Configure the links of Ethernet ring ports GigabitEthernet 0/1 and GigabitEthernet 0/2 of ERPS 2 to work in trunk mode. Create Ethernet ring R-APS VLAN 200 and add physical ports to the Ethernet ring. Specify the RPL owner port and enable the ERPS function for the Ethernet ring.

```
Node6> enable
Node6# configure terminal
Node6(config)# interface gigabitethernet 0/1
Node6(config-if-GigabitEthernet 0/1)# switchport mode trunk
Node6(config-if-GigabitEthernet 0/1)# exit
Node6(config)# interface gigabitethernet 0/2
Node6(config-if-GigabitEthernet 0/2)# switchport mode trunk
Node6(config-if-GigabitEthernet 0/2)# exit
Node6(config)# erps raps-vlan 100
Node6(config-erps 200)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node6(config-erps 200)# rpl-port east rpl-owner
Node6(config-erps 200)# state enable
```

Enable the global ERPS function.

```
Node6(config)# erps enable
```

5. Verification

Run the **show erps** command on each node to verify the configuration. The following uses node 3 as an example.

```
Node3# show erps
ERPS Information
Global Status           : Enabled
Link monitored by      : Not Oam
-----
R-APS VLAN              : 200
Ring Status             : Enabled
West Port               : Gi 0/3 (Forwarding)
East Port               : Gi 0/4 (Forwarding)
RPL Port                : None
Protected VLANs        : ALL
RPL Owner               : Disabled
Holdoff Time            : 0 milliseconds
Guard Time              : 500 milliseconds
WTR Time                : 2 minutes
Current Ring State     : Idle
Associate R-APS VLAN   :
-----
R-APS VLAN              : 100
Ring Status             : Enabled
West Port               : Gi 0/1 (Forwarding)
```



```

East Port           : Gi 0/2 (Forwarding)
RPL Port           : East Port
Protected VLANs    : ALL
RPL Owner          : Disabled
Holdoff Time       : 0 milliseconds
Guard Time        : 500 milliseconds
WTR Time           : 2 minutes
Current Ring State : Idle
Associate R-APS VLAN :
    
```

6. Common Errors

- An R-APS ring has been enabled but ERPS is not enabled globally, so ERPS does not take effect yet.
- Multiple RPL owner nodes are configured in one ring.
- Different R-APS VLANs are configured for the nodes in one ring.

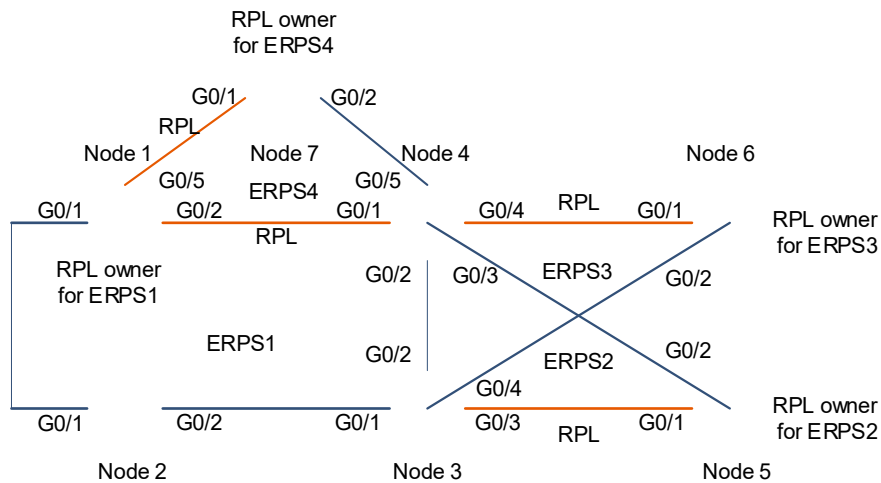
1.13.3 Configuring Intersecting-Ring Protection

1. Requirements

As shown in [Figure 1-1](#), there are four rings in the network topology. All nodes are connected in a ring in the physical topology. Nodes are connected through direct links. Each ring has only one RPL owner node and only one RPL. Two or more rings share one link. All devices in the ring network support ERPS. Configure ERPS. ERPS blocks the RPL of each ring to prevent loops, and detects faults on each link between adjacent nodes.

2. Topology

Figure 1-1 Application Scenario of Intersecting-Ring Protection



3. Notes

- Before adding a physical port to an Ethernet ring, configure the link of the member port to work in trunk mode.
- Node 1 is the intersecting node of the major ring ERPS 1 and subring ERPS 4, as well as the RPL owner node of ERPS 1. Notes for configuring this node are as follows:

- Configure R-APS VLAN 100, add GigabitEthernet 0/1 and GigabitEthernet 0/2 to R-APS VLAN 100, configure GigabitEthernet 0/2 as the RPL port, associate the major ring with subrings R-APS VLANs 200, 300, and 400, and enable the ERPS function for the Ethernet ring.
- Configure subring R-APS VLAN 400, add GigabitEthernet 0/5 and virtual channel to R-APS VLAN 400, and enable the ERPS function for the Ethernet ring.
- Enable the global ERPS function.
- Only major ring ERPS 1 passes through node 2. Notes for configuring this node are as follows:
 - Configure R-APS VLAN 100, add GigabitEthernet 0/1 and GigabitEthernet 0/2 to R-APS VLAN 100, associate the major ring with subrings R-APS VLANs 200, 300, and 400, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.
- Node 3 is the intersecting node of the major ring ERPS 1 and subrings ERPS 2 and ERPS 3. Notes for configuring this node are as follows:
 - Configure the major ring R-APS VLAN 100, add GigabitEthernet 0/1 and GigabitEthernet 0/2 to R-APS VLAN 100, associate the major ring with subrings R-APS VLANs 200, 300, and 400, and enable the ERPS function for the Ethernet ring.
 - Configure subring R-APS VLAN 200, add GigabitEthernet 0/3 and virtual channel to R-APS VLAN 200, and enable the ERPS function for the Ethernet ring.
 - Configure subring R-APS VLAN 300, add GigabitEthernet 0/4 and virtual channel to R-APS VLAN 300, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.
- Node 4 is the intersecting node of the major ring ERPS 1 and subrings ERPS 2, ERPS 3, and ERPS4. Notes for configuring this node are as follows:
 - Configure the major ring R-APS VLAN 100, add GigabitEthernet 0/1 and GigabitEthernet 0/2 to R-APS VLAN 100, associate the major ring with subrings R-APS VLANs 200, 300, and 400, and enable the ERPS function for the Ethernet ring.
 - Configure subring R-APS VLAN 200, add GigabitEthernet 0/3 and virtual channel to R-APS VLAN 200, and enable the ERPS function for the Ethernet ring.
 - Configure subring R-APS VLAN 300, add GigabitEthernet 0/4 and virtual channel to R-APS VLAN 300, and enable the ERPS function for the Ethernet ring.
 - Configure subring R-APS VLAN 400, add GigabitEthernet 0/5 and virtual channel to R-APS VLAN 400, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.
- Node 5 is the non-intersecting single-ring node of the subring ERPS 2, as well as the RPL owner node of ERPS 2. Notes for configuring this node are as follows:
 - Configure the subring R-APS VLAN 200, add GigabitEthernet 0/1 and GigabitEthernet 0/2 to R-APS VLAN 200, configure GigabitEthernet 0/1 as the RPL port, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.
- Node 6 is the non-intersecting node of the subring ERPS 3, as well as the RPL owner node of ERPS 3.

Notes for configuring this node are as follows:

- o Configure the subring R-APS VLAN 300, add GigabitEthernet 0/1 and GigabitEthernet 0/2 to R-APS VLAN 300, configure GigabitEthernet 0/1 as the RPL port, and enable the ERPS function for the Ethernet ring.
- o Enable the global ERPS function.
- Node 7 is the non-intersecting single-ring node of the subring ERPS 4, as well as the RPL owner node of ERPS 4. Notes for configuring this node are as follows:
 - o Configure the subring R-APS VLAN 400, add GigabitEthernet 0/1 and GigabitEthernet 0/2 to R-APS VLAN 400, configure GigabitEthernet 0/1 as the RPL port, and enable the ERPS function for the Ethernet ring.
 - o Enable the global ERPS function.

4. Procedure

(1) Configure node 1.

Configure the major ring ERPS 1 of the intersecting rings. Create a control VLAN (R-APS VLAN 100), add physical ports to the Ethernet ring, configure the east port as the RPL owner port, associate the major ring R-APS VLAN 100 with subrings R-APS VLANs 200, 300, and 400, and enable the ERPS function.

```
Node1> enable
Node1# configure terminal
Node1(config)# interface rang gigabitethernet 0/1-2
Node1(config-if-range)# switchport mode trunk
Node1(config-if-range)# exit
Node1(config)# erps raps-vlan 100
Node1(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node1(config-erps 100)# rpl-port east rpl-owner
Node1(config-erps 100)# exit
Node1(config-erps 100)# associate sub-ring raps-vlan 200,300,400
Node1(config-erps 100)# state enable
Node1(config-erps 100)# exit
```

Configure the subring ERPS 4 of the intersecting rings. Create a control VLAN (R-APS VLAN400), add physical ports to the Ethernet ring, and enable the ERPS function.

```
Node1(config)# interface rang gigabitethernet 0/5
Node1(config-if-range)# switchport mode trunk
Node1(config-if-range)# exit
Node1(config)# erps raps-vlan 400
Node1(config-erps 400)# ring-port west gigabitethernet 0/5 east virtual-
channel
Node1(config-erps 400)# state enable
Node1(config-erps 400)# exit
```

Enable the global ERPS function.

```
Node1(config)# erps enable
```

(2) Configure node 2.

Configure R-APS VLAN 100, add physical ports to the Ethernet ring, associate the major ring R-APS VLAN 100 with subrings R-APS VLANs 200, 300, and 400, and enable the ERPS function.

```
Node2> enable
Node2# configure terminal
Node2(config)# interface rang gigabitethernet 0/1-2
Node2(config-if-range)# switchport mode trunk
Node2(config-if-range)# exit
Node2(config)# erps raps-vlan 100
Node2(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node2(config-erps 100)# associate sub-ring raps-vlan 200,300,400
Node2(config-erps 100)# state enable
Node2(config-erps 100)# exit
```

Enable the global ERPS function.

```
Node2(config)# erps enable
```

(3) Configure node 3.

Configure the link mode for Ethernet ring ports, configure the major ring R-APS VLAN 100, add physical ports to the Ethernet ring, associate the major ring R-APS VLAN 100 with subrings R-APS VLANs 200, 300, and 400, and enable the ERPS function.

```
Node3> enable
Node3# configure terminal
Node3(config)# interface range gigabitethernet 0/1-2
Node3(config-if-range)# switchport mode trunk
Node3(config-if-range)# exit
Node3(config)# erps raps-vlan 100
Node3(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node3(config-erps 100)# associate sub-ring raps-vlan 200,300,400
Node3(config-erps 100)# state enable
Node3(config-erps 100)# exit
```

Configure the link mode for ports in ERPS 2, configure an R-APS VLAN for ERPS 2, add physical ports to the subring, and enable the ERPS function.

```
Node3(config)# interface gigabitethernet 0/3
Node3(config-if-GigabitEthernet 0/3)# switchport mode trunk
Node3(config-if-GigabitEthernet 0/3)# exit
Node3(config)# erps raps-vlan 200
Node3(config-erps 200)# ring-port west virtual-channel east gigabitethernet
0/3
Node3(config-erps 200)# state enable
Node3(config-erps 200)# exit
```

Configure the link mode for ports in ERPS 3, configure an R-APS VLAN for ERPS 3, add physical ports to the subring, and enable the ERPS function.

```
Node3(config)# interface gigabitethernet 0/4
```

```

Node3(config-if-GigabitEthernet 0/4)# switchport mode trunk
Node3(config-if-GigabitEthernet 0/4)# exit
Node3(config)# erps raps-vlan 300
Node3(config-erps 300)# ring-port west virtual-channel east gigabitethernet
0/4
Node3(config-erps 300)# state enable
Node3(config-erps 300)# exit

```

Enable the global ERPS function.

```

Node3(config)# erps enable

```

(4) Configure node 4.

Configure the link mode for ports in the major ring, configure R-APS VLAN 100, add physical ports to the Ethernet ring, associate the major ring R-APS VLAN 100 with subrings R-APS VLANs 200, 300, and 400, and enable the ERPS function.

```

Node4> enable
Node4# configure terminal
Node4(config)# interface range gigabitethernet 0/1-2
Node4(config-if-range)# switchport mode trunk
Node4(config-if-range)# exit
Node4(config)# erps raps-vlan 100
Node4(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node4(config-erps 100)# associate sub-ring raps-vlan 200,300,400
Node4(config-erps 100)# state enable
Node4(config-erps 100)# exit

```

Configure the link mode for ports in subring ERPS 2, configure an R-APS VLAN for subring ERPS 2, add physical ports to the subring, and enable the ERPS function.

```

Node4(config)# interface gigabitethernet 0/3
Node4(config-if-GigabitEthernet 0/3)# switchport mode trunk
Node4(config-if-GigabitEthernet 0/3)# exit
Node4(config)# erps raps-vlan 200
Node4(config-erps 200)# ring-port west virtual-channel east gigabitethernet
0/3
Node4(config-erps 200)# state enable
Node4(config-erps 200)# exit

```

Configure the link mode for ports in subring ERPS 3, configure an R-APS VLAN for subring ERPS 3, add physical ports to the subring, and enable the ERPS function.

```

Node4(config)# interface gigabitethernet 0/4
Node4(config-if-GigabitEthernet 0/4)# switchport mode trunk
Node4(config-if-GigabitEthernet 0/4)# exit
Node4(config)# erps raps-vlan 300
Node4(config-erps 300)# ring-port west virtual-channel east gigabitethernet
0/4
Node4(config-erps 300)# state enable
Node4(config-erps 300)# exit

```

Configure the link mode for ports in subring ERPS 4, configure an R-APS VLAN for subring ERPS 4, add physical ports to the subring, and enable the ERPS function.

```
Node4(config)# interface gigabitethernet 0/5
Node4(config-if-GigabitEthernet 0/5)# switchport mode trunk
Node4(config-if-GigabitEthernet 0/5)# exit
Node4(config)# erps raps-vlan 400
Node4(config-erps 400)# ring-port west virtual-channel east gigabitethernet
0/5
Node4(config-erps 400)# state enable
Node4(config-erps 400)# exit
```

Enable the global ERPS function.

```
Node4(config)# erps enable
```

(5) Configure node 5.

Configure the link mode for Ethernet ring ports, configure an R-APS VLAN, add physical ports to the ring, configure GigabitEthernet 0/1 as the RPL port, and enable the ERPS function.

```
Node5> enable
Node5# configure terminal
Node5(config)# interface range gigabitethernet 0/1-2
Node5(config-if-range)# switchport mode trunk
Node5(config-if-range)# exit
Node5(config)# erps raps-vlan 200
Node5(config-erps 200)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node5(config-erps 200)# rpl-port west rpl-owner
Node5(config-erps 200)# state enable
Node5(config-erps 200)# exit
```

Enable the global ERPS function.

```
Node5(config)# erps enable
```

(6) Configure node 6.

Configure the link mode for Ethernet ring ports, configure an R-APS VLAN, add physical ports to the ring, configure GigabitEthernet 0/1 as the RPL port, and enable the ERPS function.

```
Node6> enable
Node6# configure terminal
Node6(config)# interface range gigabitethernet 0/1-2
Node6(config-if-range)# switchport mode trunk
Node6(config-if-range)# exit
Node6(config)# erps raps-vlan 300
Node6(config-erps 300)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node6(config-erps 300)# rpl-port west rpl-owner
Node6(config-erps 300)# state enable
Node6(config-erps 300)# exit
```

Enable the global ERPS function.

```
Node6(config)# erps enable
```

(7) Configure node 7.

Configure the link mode for Ethernet ring ports, configure an R-APS VLAN, add physical ports to the ring, configure GigabitEthernet 0/1 as the RPL port, and enable the ERPS function.

```
Node7> enable
Node7# configure terminal
Node7(config)# interface range gigabitethernet 0/1-2
Node7(config-if-range)# switchport mode trunk
Node7(config-if-range)# exit
Node7(config)# erps raps-vlan 400
Node7(config-erps 400)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node7(config-erps 400)# rpl-port west rpl-owner
Node7(config-erps 400)# state enable
Node7(config-erps 400)# exit
```

Enable the global ERPS function.

```
Node7(config)# erps enable
```

5. Verification

Run the **show erps** command on each node to verify the configuration. The following uses node 3 as an example.

```
Node3# show erps
ERPS Information
Global Status           : Enabled
Link monitored by      : Not Oam
-----
R-APS VLAN              : 200
Ring Status             : Enabled
West Port               : Virtual Channel
East Port               : Gi 0/3 (Forwarding)
RPL Port                : None
Protected VLANs        : ALL
RPL Owner               : Disabled
Holdoff Time            : 0 milliseconds
Guard Time             : 500 milliseconds
WTR Time                : 2 minutes
Current Ring State     : Idle
Associate R-APS VLAN   :
-----
R-APS VLAN              : 300
Ring Status             : Enabled
West Port               : Virtual Channel
East Port               : Gi 0/4 (Forwarding)
RPL Port                : None
Protected VLANs        : ALL
```

```

RPL Owner          : Disabled
Holdoff Time       : 0 milliseconds
Guard Time         : 500 milliseconds
WTR Time           : 2 minutes
Current Ring State : Idle
Associate R-APS VLAN :
-----
R-APS VLAN         : 100
Ring Status        : Enabled
West Port          : Gi 0/1 (Forwarding)
East Port          : Gi 0/2 (Blocking)
RPL Port           : East Port
Protected VLANs    : ALL
RPL Owner          : Disabled
Holdoff Time       : 0 milliseconds
Guard Time         : 500 milliseconds
WTR Time           : 2 minutes
Current Ring State : Idle
Associate R-APS VLAN : 200,300,400
    
```

6. Common Errors

- An R-APS ring has been enabled but ERPS is not enabled globally, so ERPS does not take effect yet.
- Multiple RPL owner nodes are configured in one ERPS ring.
- Different R-APS VLANs are configured for the nodes in one ERPS ring.
- The nodes in the major ring are not associated with its subring.

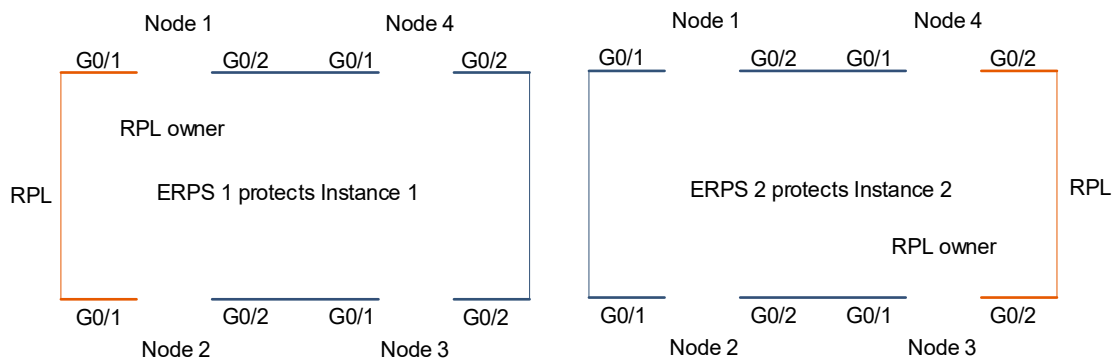
1.13.4 Configuring Load Balancing

1. Requirements

As shown in [Figure 1-1](#), two Ethernet rings are configured in the same physical network: ERPS 1 (nodes 1-2-3-4) protects VLANs 1-2000, and ERPS 2 (nodes 3-4-1-2) protects VLANs 2001-4094.

2. Topology

Figure 1-1 Application Scenario of Load Balancing



3. Notes

- Before adding a physical port to an Ethernet ring, configure the link of the member port to work in trunk mode.
- Before configuring the protected VLANs, create Instances 1 and 2 on nodes 1-4, and map instance 1 to VLANs 1-2000 and instance 2 to VLANs 2001-4094.
- ERPS 1 and ERPS 2 enabled with load balancing pass through node 1 and node 1 is the RPL owner node of ERPS 1. Notes when configuring this node are as follows:
 - Configure R-APS VLAN 100, add physical ports GigabitEthernet 0/1 and 0/2 to the Ethernet ring, configure GigabitEthernet 0/1 as the RPL port, configure the Ethernet ring to protect VLANs corresponding to instance 1, and enable the ERPS function for the Ethernet ring.
 - Configure R-APS VLAN 200, add physical ports GigabitEthernet 0/1 and GigabitEthernet 0/2 to the Ethernet ring, configure VLANs corresponding to instance 2 protected by the Ethernet ring, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.
- ERPS 1 and ERPS2 with load balancing enabled pass through node 2 and node 4, and node 2 and node 4 are non-RPL owner nodes. Notes for configuring these nodes are as follows:
 - Configure R-APS VLAN 100, add physical ports GigabitEthernet 0/1 and GigabitEthernet 0/2 to the Ethernet ring, configure VLANs corresponding to instance 1 protected by the Ethernet ring, and enable the ERPS function for the Ethernet ring.
 - Configure R-APS VLAN 200, add physical ports GigabitEthernet 0/1 and GigabitEthernet 0/2 to the Ethernet ring, configure VLANs corresponding to instance 2 protected by the Ethernet ring, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.
- ERPS 1 and ERPS 2 enabled with load balancing pass through node 3 and node 3 is the RPL owner node of ERPS 2. Notes for configuring this node are as follows:
 - Configure R-APS VLAN 100, add physical ports GigabitEthernet 0/1 and GigabitEthernet 0/2 to the Ethernet ring, configure VLANs corresponding to instance 1 protected by the Ethernet ring, and enable the ERPS function for the Ethernet ring.
 - Configure R-APS VLAN 200, add physical ports GigabitEthernet 0/1 and GigabitEthernet 0/2 to the Ethernet ring, configure GigabitEthernet 0/2 as the RPL port, configure VLANs corresponding to instance 2 protected by the Ethernet ring, and enable the ERPS function for the Ethernet ring.
 - Enable the global ERPS function.

4. Procedure

- (1) Create instance 1 and instance 2, and add protected VLAN groups to the instances. Nodes 1-4 are configured in the same way.

Configure node 1.

```
Node1> enable
Node1# configure terminal
Node1(config)# spanning-tree mst configuration
```

```
Node1(config-mst)# instance 1 vlan 1-2000
Node1(config-mst)# instance 2 vlan 2001-4094
Node1(config-mst)# exit
```

Configure node 2.

```
Node2> enable
Node2# configure terminal
Node2(config)# spanning-tree mst configuration
Node2(config-mst)# instance 1 vlan 1-2000
Node2(config-mst)# instance 2 vlan 2001-4094
Node2(config-mst)# exit
```

Configure node 3.

```
Node3> enable
Node3# configure terminal
Node3(config)# spanning-tree mst configuration
Node3(config-mst)# instance 1 vlan 1-2000
Node3(config-mst)# instance 2 vlan 2001-4094
Node3(config-mst)# exit
```

Configure node 4.

```
Node4> enable
Node4# configure terminal
Node4(config)# spanning-tree mst configuration
Node4(config-mst)# instance 1 vlan 1-2000
Node4(config-mst)# instance 2 vlan 2001-4094
Node4(config-mst)# exit
```

- (2) Configure a single-ring node, namely, node 1.

Configure the links of the Ethernet ring ports (GigabitEthernet 0/1 and GigabitEthernet 0/2) to work in trunk mode.

```
Node1(config)# interface range gigabitethernet 0/1-2
Node1(config-if-rang)# switchport mode trunk
Node1(config-if-rang)# exit
```

Configure VLANs in instance 1 protected by ERPS 1.

```
Node1(config)# erps raps-vlan 100
Node1(config-erps 100)# protected-instance 1
Node1(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node1(config-erps 100)# rpl-port west rpl-owner
Node1(config-erps 100)# state enable
Node1(config-erps 100)# exit
```

Configure VLANs in instance 2 protected by ERPS 2.

```
Node1(config)# erps raps-vlan 200
Node1(config-erps 200)# protected-instance 2
Node1(config-erps 200)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
```

```
Node1(config-erps 200)# state enable
Node1(config-erps 200)# exit
```

Enable the global ERPS function.

```
Node1(config)# erps enable
```

- (3) Configure a single-ring node, namely, node 2. The configuration commands are the same as those on node 1, except that no RPL needs to be configured.

Configure the links of the Ethernet ring ports (GigabitEthernet 0/1 and GigabitEthernet 0/2) to work in trunk mode.

```
Node2(config)# interface range gigabitethernet 0/1-2
Node2(config-if-rang)# switchport mode trunk
Node2(config-if-rang)# exit
```

Configure VLANs in instance 1 protected by ERPS 1, add the ports to the ring, specify the RPL owner port, and enable the ERPS function.

```
Node2(config)# erps raps-vlan 100
Node2(config-erps 100)# protected-instance 1
Node2(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node2(config-erps 100)# state enable
Node2(config-erps 100)# exit
```

Configure VLANs in instance 2 protected by ERPS 2, add the ports to the Ethernet ring, and enable the ERPS function.

```
Node2(config)# erps raps-vlan 200
Node2(config-erps 200)# protected-instance 2
Node2(config-erps 200)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node2(config-erps 200)# state enable
Node2(config-erps 200)# exit
```

Enable the global ERPS function.

```
Node2(config)# erps enable
```

- (4) Configure a single-ring node, namely, node 3. The commands are the same as those on node 1, except that the RPL owner port is configured on ERPS 2.

Configure the links of the Ethernet ring ports (GigabitEthernet 0/1 and GigabitEthernet 0/2) to work in trunk mode.

```
Node3(config)# interface range gigabitethernet 0/1-2
Node3(config-if-rang)# switchport mode trunk
Node3(config-if-rang)# exit
```

Configure VLANs in instance 1 protected by ERPS 1, add the ports to the ring, specify the RPL owner port, and enable the ERPS function.

```
Node3(config)# erps raps-vlan 100
Node3(config-erps 100)# protected-instance 1
Node3(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
```

```
Node3(config-erps 100)# state enable
Node3(config-erps 100)# exit
```

Configure VLANs in instance 2 protected by ERPS 2, add the ports to the Ethernet ring, and enable the ERPS function.

```
Node3(config)# erps raps-vlan 200
Node3(config-erps 200)# protected-instance 2
Node3(config-erps 200)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node3(config-erps 200)# rpl-port east rpl-owner
Node3(config-erps 200)# state enable
Node3(config-erps 200)# exit
```

Enable the global ERPS function.

```
Node3(config)# erps enable
```

- (5) Configure a single-ring node, namely, node 4. The configuration is the same as that on node 2.

Configure the links of the Ethernet ring ports (GigabitEthernet 0/1 and GigabitEthernet 0/2) to work in trunk mode.

```
Node4(config)# interface range gigabitethernet 0/1-2
Node4(config-if-rang)# switchport mode trunk
Node4(config-if-rang)# exit
```

Configure VLANs in instance 1 protected by ERPS 1, add the ports to the ring, specify the RPL owner port, and enable the ERPS function.

```
Node4(config)# erps raps-vlan 100
Node4(config-erps 100)# protected-instance 1
Node4(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node4(config-erps 100)# state enable
Node4(config-erps 100)# exit
```

Configure VLANs in instance 2 protected by ERPS 2, add the ports to the Ethernet ring, and enable the ERPS function.

```
Node4(config)# erps raps-vlan 200
Node4(config-erps 200)# protected-instance 2
Node4(config-erps 200)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/2
Node4(config-erps 200)# state enable
Node4(config-erps 200)# exit
```

Enable the global ERPS function.

```
Node4(config)# erps enable
```

5. Verification

Run the **show erps** command on each node to verify the configuration. The following uses the configuration on node 1 as an example.

```
Node1# show erps
```

```

ERPS Information
Global Status           : Enabled
Link monitored by      : Not Oam
-----
R-APS VLAN             : 100
Ring Status            : Enabled
West Port              : Gi 0/1 (Blocking)
East Port              : Gi 0/2 (Forwarding)
RPL Port               : West Port
Protected VLANs        : 1-2000
RPL Owner              : Enabled
Holdoff Time           : 0 milliseconds
Guard Time             : 500 milliseconds
WTR Time               : 2 minutes
Current Ring State     : Idle
Associate R-APS VLAN   :
-----
R-APS VLAN             : 200
Ring Status            : Enabled
West Port              : Gi 0/1 (Forwarding)
East Port              : Gi 0/2 (Blocking)
RPL Port               : West Port
Protected VLANs        : 2001-4094
RPL Owner              : Enabled
Holdoff Time           : 0 milliseconds
Guard Time             : 500 milliseconds
WTR Time               : 2 minutes
Current Ring State     : Idle
Associate R-APS VLAN   :

```

6. Common Errors

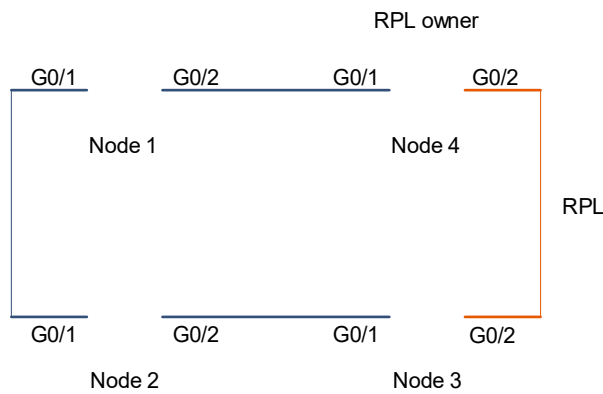
- An R-APS ring has been enabled but ERPS is not enabled globally, so ERPS does not take effect yet.
- Multiple RPL owner nodes are configured in one ERPS ring.
- Different R-APS VLANs are configured for the nodes in one ERPS ring.

1.13.5 Modifying ERPS Configuration

1. Requirements

ERPS has been configured in a ring. An ERPS port needs to be changed because of a physical topology change.

2. Topology

Figure 1-1 Application Scenario of ERPS Configuration Modification

3. Notes

- Shut down a link in the ring and configure the link mode for the new Ethernet ring port.
- Disable ERPS for the ring in R-APS VLAN mode.
- Reconfigure the ports that will participate in ERPS calculation.
- Enable the ERPS function for this ring.
- Modify the ERPS timers.

4. Procedure

(1) Configure node 1.

In interface configuration mode, shut down a link in the ring to prevent loops.

```
Node1> enable
Node1# configure terminal
Node1(config)# interface gigabitethernet 0/1
Node1(config-if-GigabitEthernet 0/1)# shutdown
Node1(config-if-GigabitEthernet 0/1)# exit
```

Configure the link mode for the new Ethernet ring port.

```
Node1(config)# interface gigabitethernet 0/3
Node1(config-if-GigabitEthernet 0/3)# switchport mode trunk
Node1(config-if-GigabitEthernet 0/3)# exit
```

Enter the R-APS VLAN configuration mode, disable the ERPS function and delete previous ring configurations.

```
Node1(config)# erps raps-vlan 100
Node1(config-erps 100)# no state enable
Node1(config-erps 100)# no ring-port
```

Modify the configuration of Ethernet ring ports, change GigabitEthernet 0/2 to GigabitEthernet 0/3, and enable the ERPS function.

```
Node1(config-erps 100)# ring-port west gigabitethernet 0/1 east
gigabitethernet 0/3
```

```
Node1(config-erps 100)# state enable
Node1(config-erps 100)# exit
```

Enable the port that is previously disabled.

```
Node1(config)# interface gigabitethernet 0/1
Node1(config-if-GigabitEthernet 0/1)# no shutdown
```

- (2) Configure node 4, enter the ERPS configuration mode, and modify timers.

```
Node4> enable
Node4# configure terminal
Node4(config)# erps raps-vlan 100
Node4(config-erps 100)# timer wtr-time 1
```

5. Verification

Wait for 1 minute. After the ERPS ring is restored to the idle state, run the **show erps** command on node 1 to verify the configuration.

```
Node1# show erps
ERPS Information
Global Status           : Enabled
Link monitored by       : Not Oam
-----
R-APS VLAN              : 100
Ring Status             : Enabled
West Port               : Gi 0/1 (Forwardin)
East Port               : Gi 0/3 (Forwardin)
RPL Port               : None
Protected VLANs        : ALL
RPL Owner               : Enabled
Holdoff Time           : 0 milliseconds
Guard Time             : 500 milliseconds
WTR Time               : 2 minutes
Current Ring State     : Idle
Associate R-APS VLAN   :
```

Wait for 1 minute. After the ERPS ring is restored to the idle state, run the **show erps** command on node 4 to verify the configuration.

```
Node4# show erps
ERPS Information
Global Status           : Enabled
Link monitored by       : Not Oam
-----
R-APS VLAN              : 100
Ring Status             : Enabled
West Port               : Gi 0/1 (Forwardin)
East Port               : Gi 0/2 (Blocking)
RPL Port               : East Port
Protected VLANs        : ALL
```

```
RPL Owner           : Enabled
Holdoff Time        : 0 milliseconds
Guard Time          : 500 milliseconds
WTR Time            : 1 minutes
Current Ring State  : Idle
Associate R-APS VLAN :
```

6. Common Errors

- The R-APS ring is not enabled after the configuration is modified.
- The ports that are previously disabled are not enabled after the configuration is modified.