

## Configuring ERPS

## 14 Configuring ERPS

### 14.1 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 designed for Ethernet rings. ERPS prevents broadcast storms caused by data loops in an idle Ethernet ring and can rapidly recover the communication between nodes in the event that a link is disconnected in the Ethernet ring.

The Spanning Tree Protocol (STP) is another technique used to solve the Layer-2 loop problem. STP is at the mature application stage but requires a relatively long (seconds) convergence time compared to ERPS. ERPS reaches a Layer-2 convergence speed of less than 50 ms, faster than that of STP.

#### Scenario

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

### 14.2 Applications

Application	Description
<a href="#">Single-Ring Protection</a>	Only one ring exists in a network topology.
<a href="#">Tangent-Ring Protection</a>	Two rings in a network topology share one device.
<a href="#">Intersecting-Ring Protection</a>	Two or more rings in a network topology share one link.

#### 14.2.1 Single-Ring Protection

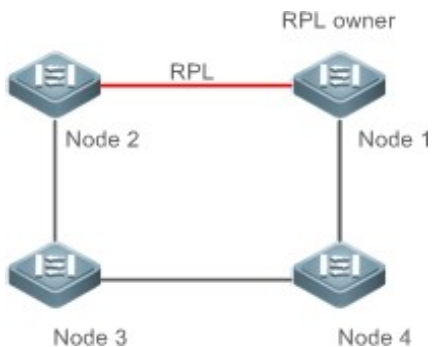
##### Scenario

Only one ring in a network topology needs to be protected.

In Figure 14-1, the network topology has only one ring, only one ring protection link (RPL) owner node, and only one RPL. All nodes must belong to the same ring automatic protection switching (R-APS) virtual local area network (VLAN).

- All devices in the ring network must support ERPS.
- Each link between devices must be a direct link without any intermediate device.

Figure 14-1



**Remarks** The four devices in the ring network are aggregation switches.

**Deployment**

- All nodes in the physical topology are connected in ring mode.
- ERPS blocks the RPL to prevent loops. In Figure 14-1, the link between Node 1 and Node 2 is an RPL.
- ERPS is used to detect failures on each link between adjacent nodes.

**14.2.2 Tangent-Ring Protection**

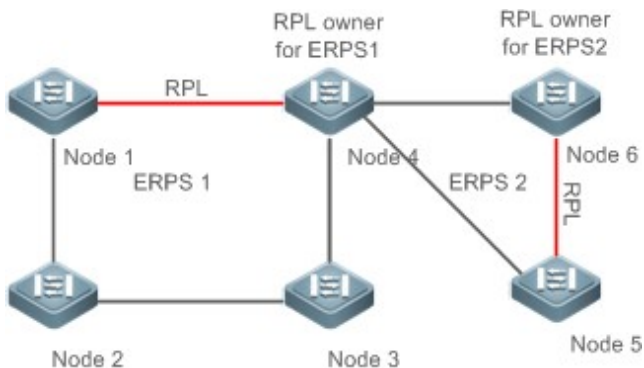
**Scenario**

The two rings in a network topology that share one device need to be protected.

In Figure 14-2, the two rings in the network topology share one device. Each ring has only one PRL owner node and only one RPL. The two 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.

Figure 14-2



<b>Remarks</b>	The devices in the ring network are aggregation switches.
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## Deployment

- All nodes in the physical topology are connected in ring mode.
- ERPS blocks the RPL of each ring to prevent loops.
- ERPS is used to detect failures on each link between adjacent nodes.

### 14.2.3 Intersecting-Ring Protection

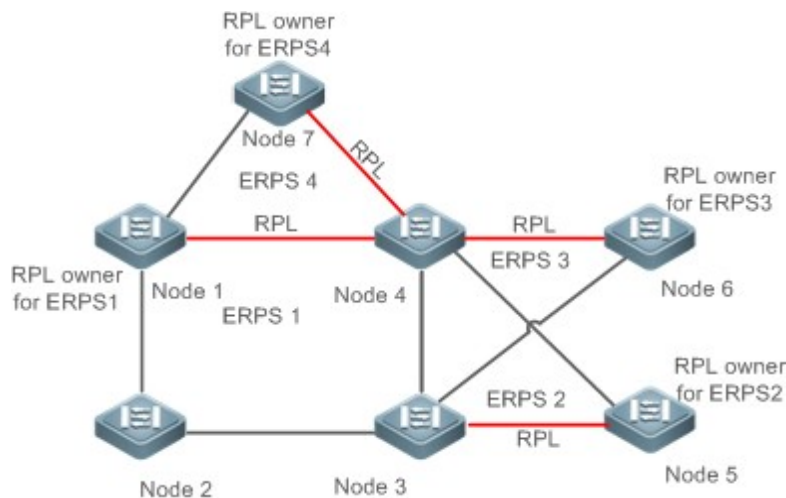
#### Scenario

Two or more rings in a network topology share one link. (Each link between intersecting nodes must be a direct link without any intermediate node.)

In Figure 14-3, four rings exist in the network topology. Each ring has only one PRL owner node and only one RPL. The four 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.

Figure 14-3



<b>Remarks</b>	The devices in the ring network are aggregation switches.
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## Deployment

- All nodes in the physical topology are connected in ring mode.
- ERPS blocks the RPL of each ring to prevent loops.
- ERPS is used to detect failures on each link between adjacent nodes.

## 14.3 Features

### Basic Concepts

#### ↳ Ethernet Ring

Ethernet rings are classified into common Ethernet rings and Ethernet subrings.

- **Common Ethernet ring:** Is an Ethernet topology with ring connection.
- **Ethernet subring:** An open topology that is mounted on other rings or networks through intersecting nodes and forms a closed topology with the channel between the intersecting nodes belonging to other rings or networks.

An Ethernet ring (a common Ethernet ring or an Ethernet subring) can be in one of the following states:

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

#### ↳ Link and Channel

- **RPL:** An Ethernet ring (a common Ethernet ring or an Ethernet subring) has only one RPL. When an Ethernet ring is idle, the RPL is blocked and does not forward data packets to prevent loops. In Figure 14-2, the link between Node 1 and Node 4 is the RPL of ERPS 1, and Node 4 blocks the RPL port (the port mapped to the RPL). The link between Node 4 and Node 5 is the RPL of ERPS 2, and Node 5 blocks the RPL port.
- **Subring link:** Belongs to a subring in intersecting rings and is controlled by the subring. In Figure 14-3, ERPS 1 is a common Ethernet ring, and ERPS 2 is an Ethernet subring. The link between Node 4 and Node 5 and the link between Node 3 and Node 5 belong to ERPS 2. The other links belong to ERPS 1.

**i** The link between Node 3 and Node 4 belongs to ERPS 1 rather than ERPS 2, and the link is not controlled by ERPS 2.

- **R-APS virtual channel:** Transmits ERPS packets of subrings between intersecting nodes in intersecting rings, but it does not belong to the subring. In Figure 14-3, Node 1 blocks the RPL, and the packets of subring ERPS 2 are transmitted through the direct link between Node 3 and Node 4 in Ethernet ring ERPS 1. The direct link between Node 3 and Node 4 is the R-APS virtual channel of ERPS 2.

#### ↳ Node

Each device in an Ethernet ring is a node.

ERPS has the following node roles for a specific Ethernet ring:

- **RPL owner node:** 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. An Ethernet ring (a common Ethernet ring or an Ethernet subring) has only one RPL owner node. In Figure 14-2, Node 1 functions as the RPL owner node of Ethernet ring ERPS 1, and Node 6 functions as the RPL owner node of Ethernet subring ERPS 2.
- **Non-RPL owner node:** Any other node than the RPL owner node in an Ethernet ring. In Figure 14-2, nodes except Node 1 and Node 6 are non-RPL owner nodes of their respective rings.

ERPS has the following roles globally (not for a specific Ethernet ring):

- **Intersecting node:** A node that belongs to multiple intersecting Ethernet rings. In Figure 14-3, Node 3 and Node 4 are intersecting nodes.
- **Non-intersecting node:** A node that belongs to only one intersecting Ethernet ring. In Figure 14-3, Node 2 is a non-intersecting node.

#### ↘ VLAN

ERPS supports two types of VLAN: R-APS VLAN and data VLAN.

- **R-APS VLAN:** A VLAN for transmitting ERPS packets. On a device, the ports accessing an ERPS ring belong to the R-APS VLAN, and only such ports can join the R-APS VLAN. R-APS VLANs of different ERPS rings must be different. IP address configuration is prohibited on the R-APS VLAN ports.
- **Data VLAN:** A VLAN for transmitting data packets. Both ERPS ports and non-ERPS ports can be assigned to a data VLAN.

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**i** R-APS VLANs of different ERPS rings must be configured differently to differentiate packets of different ERPS rings; otherwise, ERPS may be abnormal.

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#### ↘ ERPS Packet

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

- **SF packet:** When the link of a node is down, the node sends SF packets 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.
- **(RR, RB) packet:** When all nodes in an ERPS ring function properly, the RPL owner node sends (RR, RB) packets periodically.
- **Flush packet:** In an intersecting ring, 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.

#### ↘ ERPS Timer

ERPS timers include the Holdoff timer, Guard timer, and WTR timer.

- **Holdoff 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:** Is used to prevent a device from receiving expired R-APS messages. When the device detects that a link failure is cleared, it sends link recovery packets and starts the Guard timer. During the period before timer expiration, all packets except flush packets indicating a subring topology change will be discarded.
- **Wait-to-restore (WTR) timer:** Is effective only for RPL owner devices to avoid ring status misjudgment. When an RPL owner device detects that a failure is cleared, it does 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 timer expiration, the RPL owner device cancels the timer and does not perform topology switching.

## Overview

Feature	Description
<a href="#">Ring Protection</a>	Prevents broadcast storms caused by data loops and can rapidly recover the communication between nodes in the event that a link is disconnected in the Ethernet ring.
<a href="#">Load Balancing</a>	Configures multiple Ethernet subrings in one ring network and forwards the traffic of different VLANs through different Ethernet subrings to balance load.

### 14.3.1 Ring Protection

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

#### Working Principle

##### Normal Status

- All nodes in the physical topology are connected in ring mode.
- ERPS blocks the RPL to prevent loops.
- ERPS is used to detect failures on each link between adjacent nodes.

##### Link Failure

- A node adjacent to a failed node detects the failure.
- The nodes adjacent to a failed link block the failed link and send SF packets to notify other nodes in the same ring.
- The R-APS (SF) packet triggers the RPL owner node to unblock the RPL port. All nodes update their MAC address entries and ARP/ND entries and the ring enters the protection state.

##### Link Recovery

- When a failed link is restored, adjacent nodes still block the link and send NR packets indicating that no local failure exists.
- When the RPL owner node receives the first R-APS (NR) packet, it starts the WTR timer.
- When the timer times out, the RPL owner node blocks the RPL and sends an (NR, RB) packet.
- After receiving the (NR, RB) packet, other nodes update their MAC address entries and ARP/ND entries, and the node that sends the NR packet stops periodic packet transmission and unblocks the port.
- The ring network is restored to the normal state.

#### Related Configuration

##### Configuring the R-APS VLAN

By default, no R-APS VLAN is configured.

Run the **erps raps-vlan** command to configure the R-APS VLAN (management VLAN) of an ERPS ring to transmit ERPS packets.

#### ▾ Configuring an ERPS Ring

Run the **rpl-port** command in R-APS VLAN mode to configure the ERPS ring mapped to an R-APS VLAN.

#### ▾ Configuring an RPL and an RPL Owner Node

Run the **rpl-port** command in R-APS VLAN mode to specify an RPL and an RPL owner node.

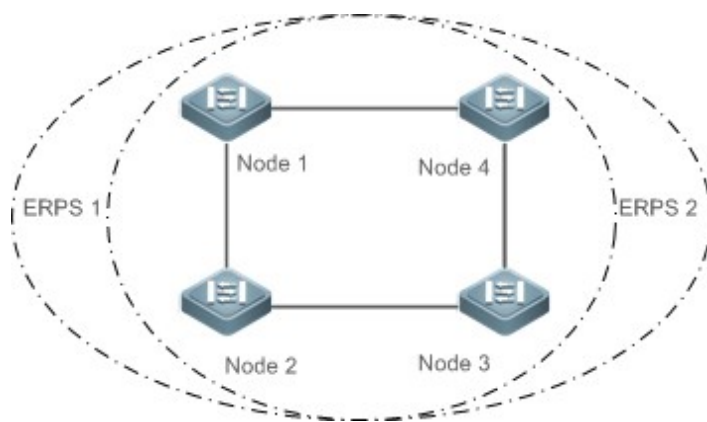
### 14.3.2 Load Balancing

You can configure multiple Ethernet subrings in one physical ring network and forward the traffic of different VLANs through different Ethernet subrings to balance load.

#### Working Principle

The multiple VLANs in a ring network can have their respective traffic forwarded by different paths through ERPS to balance load.

Figure 14-4 Single-Ring Load Balancing



In a physical ring network, multiple Ethernet rings can be configured to forward traffic of different VLANs (called protected VLANs) by different topologies to realize load balancing.

In Figure 14-4, two Ethernet rings are configured with different protected VLANs in the physical ring network. Node 1 is the RPL owner node of ERPS 1 and Node 3 is RPL owner node of ERPS 2. With such configurations, data of different VLANs can be transmitted by different links to realize single-ring load balancing.







#### Related Configuration

##### ▾ Configuring the Protected VLAN of an Ethernet Ring

Run the **protected-instance** command in R-APS VLAN mode to configure a protected VLAN set to realize load balancing.



## 14.4 Configuration

Configuration	Description and Command	
<a href="#">Single-Ring Configuration (Basic Function)</a>	 (Mandatory) Perform this configuration in global configuration mode.	
	<b>erps enable</b>	Enables ERPS.
	<b>erps raps-vlan</b>	Configures the R-APS VLAN of an Ethernet ring.
	 (Mandatory) Perform this configuration in R-APS VLAN mode.	
	<b>ring-port</b>	Configures an ERPS ring.
	<b>rpl-port</b>	Configures the RPL owner node.
	<b>state enable</b>	Enables the specified R-APS ring.
<a href="#">Tangent-Ring Configuration</a>	 Tangent-ring configuration is based on single-ring configuration.	
<a href="#">Intersecting-Ring Configuration</a>	 (Optional) Perform this configuration in R-APS VLAN mode based on single-ring configuration.	
	<b>associate sub-ring raps-vlan</b>	Associates Ethernet subrings.
	<b>sub-ring tc-propagation enable</b>	Enables subring topology change notification.
<a href="#">Load Balancing Configuration</a>	 (Optional) Perform this configuration in R-APS VLAN mode based on single-ring configuration.	
	<b>protected-instance</b>	Configures the protected VLAN of an Ethernet ring.
<a href="#">ERPS Configuration Modification</a>	 (Optional) Perform this configuration in R-APS VLAN mode based on single-ring configuration.	
	<b>timer</b>	Modifies timer parameters.

### 14.4.1 Single-Ring Configuration (Basic Function)

#### Configuration Effect

- The single-ring scenario is the basic scenario of ERPS.
- Build an ERPS single-ring topology to realize data link redundancy.
- In an ERPS ring network, quickly switch services from a failed link to a normal link.

#### Notes

- Only one RPL owner node and only one RPL can be configured in one ERPS ring.
- All nodes in one ERPS ring must belong to the same R-APSVLAN.

- Only trunk ports can join an ERPS ring, and the trunk attributes cannot be modified after the port joins the ring.
- The ports in an ERPS ring do not participate in STP calculation regardless of whether the ERPS ring is enabled or not. When you configure an ERPS ring, ensure that loops will not occur when STP calculation is disabled on ports in the ring.
- ERPS does not use the same ports as RERP and REUP.

## Configuration Steps

### ↘ Configuring the R-APS VLAN of an Ethernet Ring

- (Mandatory) Perform this configuration in global configuration mode.
- Configure the same R-APS VLAN on all switches in the ERPS ring to transmit ERPS packets.

### ↘ Configuring ERPS Ring Ports

- (Mandatory) Perform this configuration in R-APS VLAN mode.
- Configure the ports that form the ERPS ring as ERPS ring ports.

### ↘ Configuring an RPL Owner Port

- (Mandatory) Perform this configuration in R-APS VLAN mode.
- Configure a single device in each ERPS ring as an RPL owner node, which will control the port to be blocked.

### ↘ Enabling the Specified R-APS Ring

- (Mandatory) Perform this configuration in R-APS VLAN mode.
- Enable the specified R-APS ring in the same R-APS VLAN on each switch.

### ↘ Enabling ERPS Globally

- (Mandatory) Perform this configuration in global configuration mode.
- Enable ERPS globally on each switch in the ERPS ring.

## Verification

- Run the **show erps** command on each node to check the configuration.

## Related Commands

### ↘ Configuring the R-APS VLAN of an Ethernet Ring

<b>Command</b>	<code>erps raps-vlan <i>vlan-id</i></code>
<b>Parameter</b>	<i>vlan-id</i> : R-APS VLAN ID
<b>Description</b>	
<b>Command Mode</b>	Global configuration mode

<b>Usage Guide</b>	ERPS takes effect in a ring only after ERPS is enabled globally and for the ring respectively.
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### ↘ Configuring an ERPS Ring

<b>Command</b>	<b>ring-port west</b> { <i>interface-name1</i>   <b>virtual-channel</b> } <b>east</b> { <i>interface-name2</i>   <b>virtual-channel</b> }
<b>Parameter Description</b>	<i>interface-name1</i> : Indicates the name of the West port. <i>interface-name2</i> : Indicates the name of the East port. <b>virtual-channel</b> : Assigns a port to a virtual link.
<b>Command Mode</b>	R-APS VLAN mode
<b>Usage Guide</b>	The R-APS VLAN must be the unused VLAN on a device. VLAN 1 cannot be configured as the R-APS VLAN. In an Ethernet ring, different devices must be configured with the same R-APS VLAN. If you need to transparently transmit ERPS packets on a device not configured with ERPS, ensure that only the two ports on the device connected to the ERPS ring allow packets from the R-APS 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.

### ↘ Configuring an RPL Owner Port

<b>Command</b>	<b>rpl-port</b> { <b>west</b>   <b>east</b> } <b>rpl-owner</b>
<b>Parameter Description</b>	<b>west</b> : Specifies the West port as an RPL owner port. <b>east</b> : Specifies the East port as an RPL owner port.
<b>Command Mode</b>	R-APS VLAN mode
<b>Usage Guide</b>	Each ring can be configured with only one RPL and only one RPL owner node.

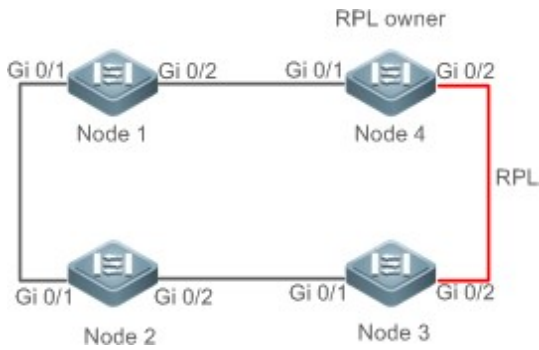
### ↘ Enabling the Specified R-APS Ring

<b>Command</b>	<b>state enable</b>
<b>Parameter Description</b>	N/A
<b>Command Mode</b>	R-APS VLAN mode
<b>Usage Guide</b>	ERPS takes effect in a ring only after ERPS is enabled globally and for the ring respectively.

### ↘ Enabling ERPS Globally

<b>Command</b>	<b>erps enable</b>
<b>Parameter Description</b>	N/A
<b>Command Mode</b>	Global configuration mode
<b>Usage Guide</b>	ERPS takes effect in a ring only after ERPS is enabled globally and for the ring respectively.

## Configuration Example

<b>Scenario</b>	
<b>Configuration Steps</b>	<ul style="list-style-type: none"> <li>✘ Configure the R-APS VLAN in privileged mode.</li> <li>✘ Configure the link mode of ports in the Ethernet ring.</li> <li>✘ Enter R-APS VLAN mode and configure the ports to be added to the Ethernet ring and participate in ERPS calculation.</li> <li>✘ Specify the RPL owner port.</li> <li>✘ Enable ERPS in the specified ring.</li> <li>✘ Enable ERPS globally.</li> </ul>
<b>Node 1</b>	<pre># Enter privileged mode. Switch#configure terminal  # Configure the R-APS VLAN. Switch(config)# erps raps-vlan 4093 Switch(config-erps 4093)# exit  # Configure the link mode of ports in the Ethernet ring. Switch(config)# interface gigabitEthernet 0/1 Switch(config-if-gigabitEthernet 0/1)# switchport mode trunk Switch(config-if-gigabitEthernet 0/1)# exit Switch(config)# interface gigabitEthernet 0/2 Switch(config-if-gigabitEthernet 0/2)# switchport mode trunk Switch(config-if-gigabitEthernet 0/2)# exit  # Enter ERPS configuration mode. Switch(config)# erps raps-vlan 4093  # Configure the ports to be added to the Ethernet ring and participate in ERPS calculation. Switch(config-erps 4093)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/2  # Enable ERPS in the specified ring.</pre>

	<pre>Switch(config-erps 4093)# state enable</pre> <p># Enable ERPS globally.</p> <pre>Switch(config-erps 4093)# exit</pre> <pre>Switch(config)# erps enable</pre>
<b>Node 2</b>	The configuration on Node 2 is the same as that on Node 1.
<b>Node 3</b>	The configuration on Node 3 is the same as that on Node 1.
<b>Node 4</b>	<pre># Enter privileged mode.</pre> <pre>Switch# configure terminal</pre> <p># Configure the R-APS VLAN.</p> <pre>Switch(config)# erps raps-vlan 4093</pre> <pre>Switch(config-erps 4093)# exit</pre> <p># Configure the link mode of ports in the Ethernet ring.</p> <pre>Switch(config)# interface gigabitEthernet 0/1</pre> <pre>Switch(config-if-gigabitEthernet 0/1)# switchport mode trunk</pre> <pre>Switch(config-if-gigabitEthernet 0/1)# exit</pre> <pre>Switch(config)# interface gigabitEthernet 0/2</pre> <pre>Switch(config-if-gigabitEthernet 0/2)# switchport mode trunk</pre> <pre>Switch(config-if-gigabitEthernet 0/2)# exit</pre> <p># Enter ERPS configuration mode.</p> <pre>Switch(config)# erps raps-vlan 4093</pre> <p># Configure the ports to be added to the Ethernet ring and participate in ERPS calculation.</p> <pre>Switch(config-erps 4093)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/2</pre> <p># Specify the RPL owner port.</p> <pre>Switch(config-erps 4093)# rpl-port east rpl-owner</pre> <p># Enable ERPS in the specified ring.</p> <pre>Switch(config-erps 4093)# state enable</pre> <pre>Switch(config-erps 4093)# exit</pre> <p># Enable RPS globally.</p> <pre>Switch(config)# erps enable</pre>
<b>Verification</b>	Run the <b>show erps</b> command on each node to check the configuration. The configuration on Node 1 and Node 4 is used as an example.

<p><b>Node 1</b></p>	<pre> Switch# show erps  ERPS Information  Global Status           : Enabled  Link monitored by       : Not Oam  R-APS VLAN              : 4093  Ring Status             : Enabled  West Port               : Gi 0/1 (Forwardin)  East Port               : Gi 0/2 (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   :                 </pre>
<p><b>Node 4</b></p>	<pre> Switch# show erps  ERPS Information  Global Status           : Enabled  Link monitored by       : Not Oam  -----  R-APS VLAN              : 4093  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                 </pre>

WTR Time	: 2 minutes
Current Ring State	: Idle
Associate R-APS VLAN	:

## Common Errors

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

## 14.4.2 Tangent-Ring Configuration

### Configuration Effect

- Configure a tangent ring that consists of two ERPS rings sharing one device to realize data link redundancy.
- Quickly switch services from a failed link in one ERPS ring to a normal link.

### Notes

- The tangent-ring configuration is basically the same as the single-ring configuration. You only need to associate the two ERPS rings on the tangent node.
- Only one RPL owner node and only one RPL can be configured in each ERPS ring.
- All nodes in one ERPS ring must belong to the same R-APSVLAN.
- Only trunk ports can join an ERPS ring, and the trunk attributes cannot be modified after the port joins the ring.
- The ports in an ERPS ring do not participate in STP calculation regardless of whether the ERPS ring is enabled or not. When you configure an ERPS ring, ensure that loops will not occur when STP calculation is disabled on ports in the ring.
- ERPS does not use the same ports as RERP and REUP.

### Configuration Steps

- The tangent-ring configuration is basically the same as the single-ring configuration. You only need to associate the two ERPS rings on the tangent node.

### Verification

- Run the **show erps** command on each node to check the configuration.

### Related Commands

- See the commands in section 14.4.1 "Single-Ring Configuration (Basic Function)."

## Configuration Example

<b>Scenario</b>	
<b>Configuration Steps</b>	<ul style="list-style-type: none"> <li>\ Configure the R-APS VLAN in privileged mode.</li> <li>\ Configure the link mode of ports in the Ethernet ring.</li> <li>\ Enter R-APS VLAN mode and configure the ports to be added to the Ethernet ring and participate in ERPS calculation.</li> <li>\ Specify the RPL owner port.</li> <li>\ Enable ERPS in the specified ring.</li> <li>\ Enable ERPS globally.</li> </ul>
<b>Node 1</b>	<pre># Enter privileged mode.  Switch# configure terminal  # Configure R-APS VLAN 4093.  Switch(config)# erps raps-vlan 4093  Switch(config-erps 4093)# exit  # Configure the link mode of ports in the Ethernet ring.  Switch(config)# interface gigabitEthernet 0/1  Switch(config-if-gigabitEthernet 0/1)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/1)# exit  Switch(config)# interface gigabitEthernet 0/2  Switch(config-if-gigabitEthernet 0/2)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/2)# exit  # Enter ERPS configuration mode.  Switch(config)# erps raps-vlan 4093  # Configure the ports to be added to the Ethernet ring and participate in ERPS calculation.  Switch(config-erps 4093)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/2</pre>



	<pre> # Enable ERPS in the specified ring.  Switch(config-erps 4093)# state enable  Switch(config-erps 4093)# exit  # Enable ERPS globally.  Switch(config)# erps enable </pre>
<b>Node 2</b>	The configuration on Node 2 is the same as that on Node 1.
<b>Node 3</b>	<pre> Switch# configure terminal  # Configure R-APS VLAN 4093.  Switch(config)# erps raps-vlan 4093  Switch(config-erps 4093)# exit  # Configure the link mode of ports in the Ethernet ring.  Switch(config)# interface gigabitEthernet 0/1  Switch(config-if-gigabitEthernet 0/1)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/1)# exit  Switch(config)# interface gigabitEthernet 0/2  Switch(config-if-gigabitEthernet 0/2)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/2)# exit  # Enter ERPS configuration mode.  Switch(config)# erps raps-vlan 4093  Switch(config-erps 4093)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/2  Switch(config-erps 4093)# state enable  Switch(config-erps 4093)# exit  # Configure R-APS VLAN 100.  Switch(config)# erps raps-vlan 100  Switch(config-erps 100)# exit  Switch(config)# interface gigabitEthernet 0/3  Switch(config-if-gigabitEthernet 0/3)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/3)# exit  Switch(config)# interface gigabitEthernet 0/4  Switch(config-if-gigabitEthernet 0/4)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/4)# exit  # Enter ERPS configuration mode. </pre>

	<pre>Switch(config)# erps raps-vlan 100  Switch(config-erps 100)# ring-port west gigabitEthernet 0/3 east gigabitEthernet 0/4  Switch(config-erps 100)# state enable  Switch(config-erps 4093)# exit  Switch(config)# erps enable</pre>
<b>Node 4</b>	<pre>Switch# configure terminal  <b># Configure R-APS VLAN 4093.</b>  Switch(config)# erps raps-vlan 4093  Switch(config-erps 4093)# exit  <b># Configure the link mode of ports in the Ethernet ring.</b>  Switch(config)# interface gigabitEthernet 0/1  Switch(config-if-gigabitEthernet 0/1)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/1)# exit  Switch(config)# interface gigabitEthernet 0/2  Switch(config-if-gigabitEthernet 0/2)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/2)# exit  <b># Enter ERPS configuration mode.</b>  Switch(config)# erps raps-vlan 4093  Switch(config-erps 4093)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/2  <b># Specify the RPL owner port.</b>  Switch(config-erps 4093)# rpl-port east rpl-owner  Switch(config-erps 4093)# state enable  Switch(config-erps 4093)# exit  Switch(config)# erps enable</pre>
<b>Node 5</b>	<pre>Switch# configure terminal  <b># Configure R-APS VLAN 100.</b>  Switch(config)# erps raps-vlan 100  Switch(config-erps 100)# exit  <b># Configure the link mode of ports in the Ethernet ring.</b>  Switch(config)# interface gigabitEthernet 0/1  Switch(config-if-gigabitEthernet 0/1)# switchport mode trunk</pre>

	<pre>Switch(config-if-gigabitEthernet 0/1)# exit Switch(config)# interface gigabitEthernet 0/2 Switch(config-if-gigabitEthernet 0/2)# switchport mode trunk Switch(config-if-gigabitEthernet 0/2)# exit  # Enter ERPS configuration mode. Switch(config)# erps raps-vlan 100 Switch(config-erps 100)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/2 Switch(config-erps 100)# state enable Switch(config-erps 100)# exit Switch(config)# erps enable</pre>
<b>Node 6</b>	<pre>Switch# configure terminal  # Configure R-APS VLAN 100. Switch(config)# erps raps-vlan 100 Switch(config-erps 100)# exit  # Configure the link mode of ports in the Ethernet ring. Switch(config)# interface gigabitEthernet 0/1 Switch(config-if-gigabitEthernet 0/1)# switchport mode trunk Switch(config-if-gigabitEthernet 0/1)# exit Switch(config)# interface gigabitEthernet 0/2 Switch(config-if-gigabitEthernet 0/2)# switchport mode trunk Switch(config-if-gigabitEthernet 0/2)# exit  # Enter ERPS configuration mode. Switch(config)# erps raps-vlan 100 Switch(config-erps 100)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/2  # Specify the RPL owner port. Switch(config-erps 100)# rpl-port east rpl-owner Switch(config-erps 100)# state enable Switch(config)# erps enable</pre>
<b>Verification</b>	Run the <b>show erps</b> command on each node to check the configuration. The configuration on Node 3 is used as an example.
	<pre>Switch# show erps</pre>

ERPS Information	
Global Status	: Enabled
Link monitored by	: Not Oam
-----	
R-APS VLAN	: 100
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	: 4093
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	:

## Common Errors

- The R-APS ring has been enabled but ERPS is not enabled globally, so ERPS still does not take effect.

- Multiple RPL owner nodes are configured in one ring.
- Different R-APS VLANs are configured for the nodes in one ring.

### 14.4.3 Intersecting-Ring Configuration

#### Configuration Effect

- Configure multiple ERPS rings to share links, thus realizing data link redundancy.
- Quickly switch services from a failed link in one ERPS ring to a normal link.

#### Notes

- Only one RPL owner node and only one RPL can be configured in each ERPS ring.
- All nodes in one ERPS ring must belong to the same R-APSVLAN.
- All nodes in the Ethernet ring must be associated with their respective subrings.
- Only trunk ports can join an ERPS ring, and the trunk attributes cannot be modified after the port joins the ring.
- The ports in an ERPS ring do not participate in STP calculation regardless of whether the ERPS ring is enabled or not. When you configure an ERPS ring, ensure that loops will not occur when STP calculation is disabled on ports in the ring.
- ERPS does not use the same ports as RERP and REUP.

#### Configuration Steps

Perform the following configuration after you complete the single-ring configuration described above:

##### ↳ Enabling Subring Topology Change Notification

- (Optional) Perform this configuration in R-APS VLAN mode.
- Enable subring topology change notification on intersecting nodes.
- If 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.

##### ↳ Associating Ethernet Subrings

- (Optional) Perform this configuration in R-APS VLAN mode.
- Associate nodes in the main ring with Ethernet subrings.
- After nodes are associated with Ethernet subrings, ERPS packets of the subrings can be transmitted to other Ethernet rings.

#### Verification

- Run the **show erps** command on each node to check the configuration.

## Related Commands

### ↳ Enabling Subring Topology Change Notification

<b>Command</b>	<b>sub-ring tc-propagation enable</b>
<b>Parameter Description</b>	N/A
<b>Command Mode</b>	R-APS VLAN mode
<b>Usage Guide</b>	Run this command only on intersecting nodes.

### ↳ Associating Ethernet Subrings

<b>Command</b>	<b>associate sub-ring raps-vlan <i>vlan-list</i></b>
<b>Parameter Description</b>	<i>vlan-list</i> : Indicates the R-APS VLANs of subrings.
<b>Command Mode</b>	R-APS VLAN mode
<b>Usage Guide</b>	Run this command on all nodes in the Ethernet ring to allow its subrings to transmit ERPS packets to the Ethernet ring.  After nodes are associated with subrings, ERPS packets of the subrings can be transmitted to other Ethernet rings. You can also use the command provided by the VLAN module to configure VLAN and its member ports to allow ERPS packets of subrings to be transmitted to other Ethernet rings while avoiding information leakage to user networks.

## Configuration Example

<b>Scenario</b>	
<b>Configuration</b>	<ul style="list-style-type: none"> <li>Configure the R-APS VLAN in privileged mode.</li> </ul>

<b>Steps</b>	<ul style="list-style-type: none"> <li>✎ Configure the link mode of ports in the Ethernet ring.</li> <li>✎ Enter R-APS VLAN mode and configure the ports to be added to the Ethernet ring and participate in ERPS calculation.</li> <li>✎ Specify the RPL owner port.</li> <li>✎ Enable ERPS in the specified ring.</li> <li>✎ Associate nodes in the Ethernet ring with subrings.</li> <li>✎ Enable subring topology change notification on intersecting nodes.</li> <li>✎ Enable ERPS globally.</li> </ul>
<b>Node 1</b>	<pre># Enter privileged mode. Switch# configure terminal  # Configure R-APS VLAN 4093. Switch(config)# erps raps-vlan 4093 Switch(config-erps 4093)# exit  # Configure the link mode of ports in the Ethernet ring. Switch(config)# interface gigabitEthernet 0/1 Switch(config-if-gigabitEthernet 0/1)# switchport mode trunk Switch(config-if-gigabitEthernet 0/1)# exit Switch(config)# interface gigabitEthernet 0/2 Switch(config-if-gigabitEthernet 0/2)# switchport mode trunk Switch(config-if-gigabitEthernet 0/2)# exit  # Enter ERPS configuration mode. Switch(config)# erps raps-vlan 4093  # Configure the ports to be added to the Ethernet ring and participate in ERPS calculation. Switch(config-erps 4093)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/2  # Specify the port and RPL owner node for the RPL. Switch(config-erps 4093)# rpl-port east rpl-owner  # Enable ERPS in the specified ring. Switch(config-erps 4093)# state enable  # Enable ERPS globally. Switch(config-erps 4093)# exit Switch(config)# erps enable  # Configure the R-APS VLAN of the subring ERPS 4. Switch(config)# erps raps-vlan 300</pre>

	<pre>Switch(config-erps 300)# exit  # Configure the link mode of ports in ERPS 4.  Switch(config)# interface gigabitEthernet 0/5  Switch(config-if-gigabitEthernet 0/5)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/5)# exit  # Enter ERPS configuration mode.  Switch(config)# erps raps-vlan 300  # Configure the ports to be added to the Ethernet ring and participate in ERPS calculation.  Switch(config-erps 300)# ring-port west gigabitEthernet 0/5 east virtual-channel  # Enable ERPS in ERPS 4.  Switch(config-erps 300)# state enable  # Associate ERPS 1 with ERPS 2, ERPS 3, and ERPS 4.  Switch(config-erps 300)# exit  Switch(config)# erps raps-vlan 4093  Switch(config-erps 4093)# associate sub-ring raps-vlan 100,200,300</pre>
<b>Node 2</b>	<pre># Enter privileged mode.  Switch# configure terminal  # Configure R-APS VLAN 4093.  Switch(config)# erps raps-vlan 4093  Switch(config-erps 4093)# exit  # Configure the link mode of ports in the Ethernet ring.  Switch(config)# interface gigabitEthernet 0/1  Switch(config-if-gigabitEthernet 0/1)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/1)# exit  Switch(config)# interface gigabitEthernet 0/2  Switch(config-if-gigabitEthernet 0/2)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/2)# exit  # Enter ERPS configuration mode.  Switch(config)# erps raps-vlan 4093  # Configure the ports to be added to the Ethernet ring and participate in ERPS calculation.  Switch(config-erps 4093)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/2  # Enable ERPS in the specified ring.</pre>



	<pre>Switch(config-erps 4093)# state enable  # Enable ERPS globally.  Switch(config-erps 4093)# exit  Switch(config)# erps enable  # Associate ERPS 1 with ERPS 2, ERPS 3, and ERPS 4.  Switch(config)# erps raps-vlan 4093  Switch(config-erps 4093)# associate sub-ring raps-vlan 100,200,300</pre>
<b>Node 3</b>	<pre># Perform the following configuration on Node 3 based on the configuration on Node 2: # Enter privileged mode.  Switch# configure terminal  # Configure the R-APS VLAN of the subring ERPS 2.  Switch(config)# erps raps-vlan 100  Switch(config-erps 100)# exit  # Configure the link mode of ports in ERPS 2.  Switch(config)# interface gigabitEthernet 0/3 Switch(config-if-gigabitEthernet 0/3)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/3)# exit  # Enter ERPS configuration mode.  Switch(config)# erps raps-vlan 100  # Configure the ports to be added to the Ethernet ring and participate in ERPS calculation.  Switch(config-erps 100)# ring-port west virtual-channel east gigabitEthernet 0/3  # Enable ERPS in ERPS 2.  Switch(config-erps 100)# state enable  # Configure the R-APS VLAN of the subring ERPS 3.  Switch(config)# erps raps-vlan 200  Switch(config-erps 200)# exit  # Configure the link mode of ports in ERPS 3.  Switch(config)# interface gigabitEthernet 0/4 Switch(config-if-gigabitEthernet 0/4)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/4)# exit  # Enter ERPS configuration mode.  Switch(config)# erps raps-vlan 200</pre>

	<pre> # Configure the ports to be added to the Ethernet ring and participate in ERPS calculation. Switch(config-erps 200)# ring-port west virtual-channel east gigabitEthernet 0/4  # Enable ERPS in ERPS 2. Switch(config-erps 200)# state enable  # Associate the Ethernet subrings ERPS 2, ERPS 3, and ERPS 4. Switch(config-erps 200)# exit Switch(config)# erps raps-vlan 4093 Switch(config-erps 4093)# associate sub-ring raps-vlan 100,200,300 </pre>
<b>Node 4</b>	<pre> # Perform the following configuration on Node 4 based on the configuration on Node 2. # Enter privileged mode. Switch# configure terminal  # Configure the R-APS VLAN of the subring ERPS 2. Switch(config)# erps raps-vlan 100 Switch(config-erps 100)# exit  # Configure the link mode of ports in ERPS 2. Switch(config)# interface gigabitEthernet 0/3 Switch(config-if-gigabitEthernet 0/3)# switchport mode trunk Switch(config-if-gigabitEthernet 0/3)# exit  # Enter ERPS configuration mode. Switch(config)# erps raps-vlan 100  # Configure the ports to be added to the Ethernet ring and participate in ERPS calculation. Switch(config-erps 100)# ring-port west virtual-channel east gigabitEthernet 0/3  # Enable ERPS in ERPS 2. Switch(config-erps 100)# state enable  # Configure the R-APS VLAN of the subring ERPS 3. Switch(config)# erps raps-vlan 200 Switch(config-erps 200)# exit  # Configure the link mode of ports in ERPS 3. Switch(config)# interface gigabitEthernet 0/4 Switch(config-if-gigabitEthernet 0/4)# switchport mode trunk Switch(config-if-gigabitEthernet 0/4)# exit  # Enter ERPS configuration mode. </pre>

```
Switch(config)# erps raps-vlan 200

# Configure the ports to be added to the Ethernet ring and participate in ERPS calculation.

Switch(config-erps 200)# ring-port west virtual-channel east gigabitEthernet 0/4

# Enable ERPS in ERPS 3.

Switch(config-erps 200)# state enable

# Configure the R-APS VLAN of the subring ERPS 4.

Switch(config-erps 200)# exit

Switch(config)# erps raps-vlan 300

Switch(config-erps 300)# exit

# Configure the link mode of ports in ERPS 4.

Switch(config)# interface gigabitEthernet 0/5

Switch(config-if-gigabitEthernet 0/5)# switchport mode trunk

Switch(config-if-gigabitEthernet 0/5)# exit

# Enter ERPS configuration mode.

Switch(config)# erps raps-vlan 300

# Configure the ports to be added to the Ethernet ring and participate in ERPS calculation.

Switch(config-erps 300)# ring-port west virtual-channel east gigabitEthernet 0/5

# Enable ERPS in ERPS 4.

Switch(config-erps 300)# state enable

# Associate the Ethernet subrings ERPS 2, ERPS 3, and ERPS 4.

Switch(config-erps 300)# exit

Switch(config)# erps raps-vlan 4093

Switch(config-erps4093)# associate sub-ring raps-vlan 100,200,300
```

**Node 5**

```
# Enter privileged mode.

Switch# configure terminal

# Configure the R-APS VLAN.

Switch(config)# erps raps-vlan 100

Switch(config-erps 100)# end

# Configure the link mode of ports in the Ethernet ring.

Switch(config)# interface gigabitEthernet 0/1

Switch(config-if-gigabitEthernet 0/1)# switchport mode trunk
```

	<pre>Switch(config-if-gigabitEthernet 0/1)# exit Switch(config)# interface gigabitEthernet 0/2 Switch(config-if-gigabitEthernet 0/2)# switchport mode trunk Switch(config-if-gigabitEthernet 0/2)# exit  # Enter ERPS configuration mode. Switch(config)# erps raps-vlan 100  # Configure the ports to be added to the Ethernet ring and participate in ERPS calculation. Switch(config-erps 100)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/2  # Specify the port and RPL owner node for the RPL. Switch(config-erps 100)# rpl-port east rpl-owner  # Enable ERPS in the specified ring. Switch(config-erps 100)# state enable  # Enable ERPS globally. Switch(config-erps 100)# exit Switch(config)# erps enable</pre>
<b>Node 6</b>	<p># The configuration on Node 6 is basically the same as that on Node 5, except that you need to change the R-APS VLAN to VLAN 200.</p>
<b>Node 7</b>	<p># The configuration on Node 7 is basically the same as that on Node 5, except that you need to change the R-APS VLAN to VLAN 300.</p>
<b>Verification</b>	<p>Run the <b>show erps</b> command on each node to check the configuration. The configuration on Node 3 is used as an example.</p>
	<pre>Global Status                : Enabled Link monitored by           : Not Oam  R-APS VLAN                  : 100 Ring Status                  : Enabled West Port                    : Virtual Channel East Port                    : Gi 0/3 (Forwarding) RPL Port                     : None Protected VLANs             : ALL RPL Owner                    : Disabled</pre>

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	: 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	: 4093
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	: 100, 200, 300

## Common Errors

- The R-APS ring has been enabled but ERPS is not enabled globally, so ERPS still does not take effect.
- 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 man ring are not associated with Ethernet subrings.

## 14.4.4 Load Balancing Configuration

### Configuration Effect

- Control the direction of data flows in an ERPS ring to realize loadbalancing.
- When a link in the ring network enabled with load balancing fails, the traffic can be quickly switched to a normal link.

### Notes

- Before you configure load balancing, configure the VLAN-instance relationship 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 will cause loops.
- Only trunk ports can join an ERPS ring, and the trunk attributes cannot be modified after the port joins the ring.
- The ports in an ERPS ring do not participate in STP calculation regardless of whether the ERPS ring is enabled or not. When you configure an ERPS ring, ensure that loops will not occur when STP calculation is disabled on ports in the ring.
- ERPS does not use the same ports as RERP and REUP.

### Configuration Steps

Perform the following configuration after you complete the single-ring configuration described above:

#### ✚ Configuring the Protected VLAN of an Ethernet Ring

- (Optional) Perform this configuration in global configuration mode.
- When you configure load balancing for an Ethernet ring, you must specify the protected VLAN.

### Verification

- Run the **show erps** command on each node to check the configuration.

### Related Commands

#### ✚ Configuring the Protected VLAN of an Ethernet Ring

<b>Command</b>	<b>protected-instance</b> <i>instance-id-list</i>
<b>Parameter</b>	<i>instance-id-list</i> : Indicates the instance protected by the Ethernet ring.

<b>Description</b>	
<b>Command Mode</b>	R-APS VLAN mode
<b>Usage Guide</b>	The protected instance of the Ethernet ring is the protected VLAN.

### Configuration Example

<p><b>Scenario</b></p>	
<p><b>Configuration Steps</b></p>	<ul style="list-style-type: none"> <li>✎ Configure the R-APS VLAN in privileged mode.</li> <li>✎ Configure the link mode of ports in the Ethernet ring.</li> <li>✎ Configure the protected VLAN of the Ethernet ring.</li> <li>✎ Enter R-APS VLAN mode and configure the ports to be added to the Ethernet ring and participate in ERPS calculation.</li> <li>✎ Specify the RPL owner port.</li> <li>✎ Enable ERPS in the specified ring.</li> <li>✎ Enable ERPS globally.</li> </ul>
<p><b>Node 1</b></p>	<pre># Enter privileged mode.  Switch# configure terminal  # Configure the Ethernet subring ERPS 1 as follows: # Configure the link mode of ports in ERPS 1.  Switch(config)# interface gigabitEthernet 0/1 Switch(config-if-gigabitEthernet 0/1)# switchport mode trunk Switch(config-if-gigabitEthernet 0/1)# exit  Switch(config)# interface gigabitEthernet 0/2 Switch(config-if-gigabitEthernet 0/2)# switchport mode trunk Switch(config-if-gigabitEthernet 0/2)# exit  # Configure the protected VLAN, RPL owner port, and RPL of ERPS 1.  Switch(config)# spanning-tree mst configuration</pre>

	<pre>Switch(config-mst)# instance 1 vlan 1-2000 Switch(config-mst)# exit Switch(config)# erps raps-vlan 100 Switch(config-erps 100)# protected-instance 1 Switch(config-erps 100)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/2 Switch(config-erps 100)# rpl-port west rpl-owner  # Configure the Ethernet subring ERPS 2 as follows: # Configure the ports to be added to ERPS 2 and participate in ERPS calculation.  Switch(config)# spanning-tree mst configuration Switch(config-mst)# instance 2 vlan 2001-4094 Switch(config-mst)# exit Switch(config)# erps raps-vlan 4093 Switch(config-erps 4093)# protected-instance 2 Switch(config-erps 4093)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/2  # Enable ERPS in ERPS 2 and globally respectively. Switch(config-erps 4093)# state enable Switch(config-erps 4093)# exit Switch(config)# erps enable</pre>
<b>Node 2</b>	<p># The configuration on Node 2 is the same as that on Node 1, except that RPL configuration is not required on Node 2.</p>
<b>Node 3</b>	<p># The configuration on Node 3 is the same as that on Node 1, except that RPL configuration is not required on Node 3.</p> <p># Configure the RPL of ERPS 2 on Node 3. The RPL of ERPS 1 does not need to be configured on Node 3.</p> <pre>Switch(config)# erps raps-vlan 4093 Switch(config-erps 4093)# rpl-port east rpl-owner</pre>
<b>Node 4</b>	<p>The configuration on Node 4 is the same as that on Node 2.</p>
<b>Verification</b>	<p>Run the <b>show erps</b> command one each node to check the configuration. The configuration on Node 1 is used as an example.</p>
<b>Node 1</b>	<pre>Switch# show erps  ERPS Information  Global Status                : Enabled Link monitored by            : Not Oam</pre>



```

-----
R-APS VLAN                : 200
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                : 4093
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      :

```

## Common Errors

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

## 14.4.5 ERPS Configuration Modification

### Configuration Effect

- Switch configuration smoothly when the ERPS ring topology is changed.

### Notes

- When you modify the ERPS configuration on a device, to avoid loops, first run the **shutdown** command to shut down an ERPS port in the ring. When the configuration is completed, run the **no shutdown** command to restart the port.
- All nodes in one ERPS ring must belong to the same R-APSVLAN.
- If you only need to modify the ERPS timers, skip this section.

### Configuration Steps

Run the **shutdown** command to shut down an ERPS port and disable ERPS. Then modify the ERPS configuration according to section 14.4.1 "Single-Ring Configuration (Basic Function)" and complete the following settings, which are optional.

#### ✚ Configuring the Holdoff Timer, Guard Timer, and WRT Timer

- Optional.
- Perform this configuration in R-APS VLAN mode based on the actual application requirements.

### Verification

- Run the **show erps** command one each node to check the configuration.

### Related Commands

#### ✚ Configuring the Holdoff Timer, Guard Timer, and WRT Timer

<b>Command</b>	<code>timer { holdoff-time interval1   guard-time interval2   wtr-time interval3 }</code>
<b>Parameter Description</b>	<p><i>interval1</i>: Indicates the Holdoff timer interval. The value ranges from 0 to 100, in the unit of 100 milliseconds. The default value is 0.</p> <p><i>interval2</i>: Indicates the Guard timer interval. The value ranges from 1 to 200, in the unit of 10 milliseconds. The default value is 50.</p> <p><i>interval3</i>: Indicates the WTR timer interval. The value ranges from 1 to 12, in the unit of minutes. The default value is 2.</p>
<b>Command Mode</b>	R-APS VLAN mode
<b>Usage Guide</b>	<p>✚ Holdoff 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.</p> <p>✚ Guard timer: Is used to prevent a device from receiving expired R-APS messages. When the device detects that a link failure is cleared, it sends link recovery packets and starts the Guard timer. During</p>

	<p>the period before timer expiration, all packets except flush packets indicating a subring topology change will be discarded.</p> <p>✎ WTR timer: Is effective only for RPL owner devices to avoid ring status misjudgment. When an RPL owner device detects that a failure is cleared, it does 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 timer expiration, the RPL owner device cancels the timer and does not perform topology switching.</p>
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### Configuration Example

<b>Scenario</b>	
<b>Configuration Steps</b>	<ul style="list-style-type: none"> <li>✎ ERPS configuration exists in the ring. The ERPS ports need to be switched because of a physical topology change.</li> <li>✎ Run the <b>shutdown</b> command to shut down a link in the ring and configure the link mode of ports after switching.</li> <li>✎ Disable ERPS in the ring in R-APS VLAN mode.</li> <li>✎ Reconfigure the ports that will participate in ERPS calculation.</li> <li>✎ Enable ERPS in the ring.</li> <li>✎ Modify the ERPS timers.</li> </ul>
<b>Node 1</b>	<pre># Enter privileged mode.  Switch # configure terminal  Enter configuration commands, one per line. End with CNTL/Z.  # Shutdown a link in the ring in interface configuration mode to avoid loops.  Switch(config)# interface gigabitEthernet 0/1  Switch (config-if-gigabitEthernet 0/1)# shutdown  Switch(config-if-gigabitEthernet 0/1)# exit  # Configure the link mode of ports in the Ethernet ring.  Switch(config)# interface gigabitEthernet 0/3  Switch (config-if-gigabitEthernet 0/3)# switchport mode trunk  Switch(config-if-gigabitEthernet 0/3)# exit</pre>

	<pre># Enter ERPS configuration mode. Switch(config)# erps raps-vlan 4093  # Disable ERPS. Switch(config-erps 4093)# no state enable  # Delete the previous ring configuration. Switch(config-erps 4093)# no ring-port  # Reconfigure the ports that will participate in ERPS calculation. Change Gig 0/2 to Gig 0/3. Switch(config-erps 4093)# ring-port west gigabitEthernet 0/1 east gigabitEthernet 0/3  # Enable ERPS. Switch(config-erps 4093)# state enable</pre>
<b>Node 4</b>	<pre># Enter privileged mode. Switch# configure terminal  # Modify timers in ERPS configuration mode. Switch(config)# erps raps-vlan 4093 Switch(config-erps 4093)# timer wtr-time 1</pre>
	<p>Wait for 1 minute. When the ERPS ring is restored to Idle, run the <b>show erps</b> command on Node 1 and Node 4 to check the configuration.</p>
<b>Node 1</b>	<pre>Switch# show erps ERPS Information Global Status           : Enabled Link monitored by       : Not Oam  R-APS VLAN              : 4093 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</pre>

	Current Ring State : Idle
	Associate R-APS VLAN :
<b>Node 4</b>	Switch# show erps
	ERPS Information
	Global Status : Enabled
	Link monitored by : Not Oam
	R-APS VLAN : 4093
	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 :

### Common Errors

- When the configuration is completed, the R-APS ring is not enabled again or the shutdown ports are not restarted by using the **no shutdown** command.

## 14.5 Monitoring

### Displaying

Description	Command
Displays the ERPS configuration and status of devices.	<b>show erps [ global   raps_vlan <i>vlan-id</i> [ <i>sub_ring</i> ] ]</b>