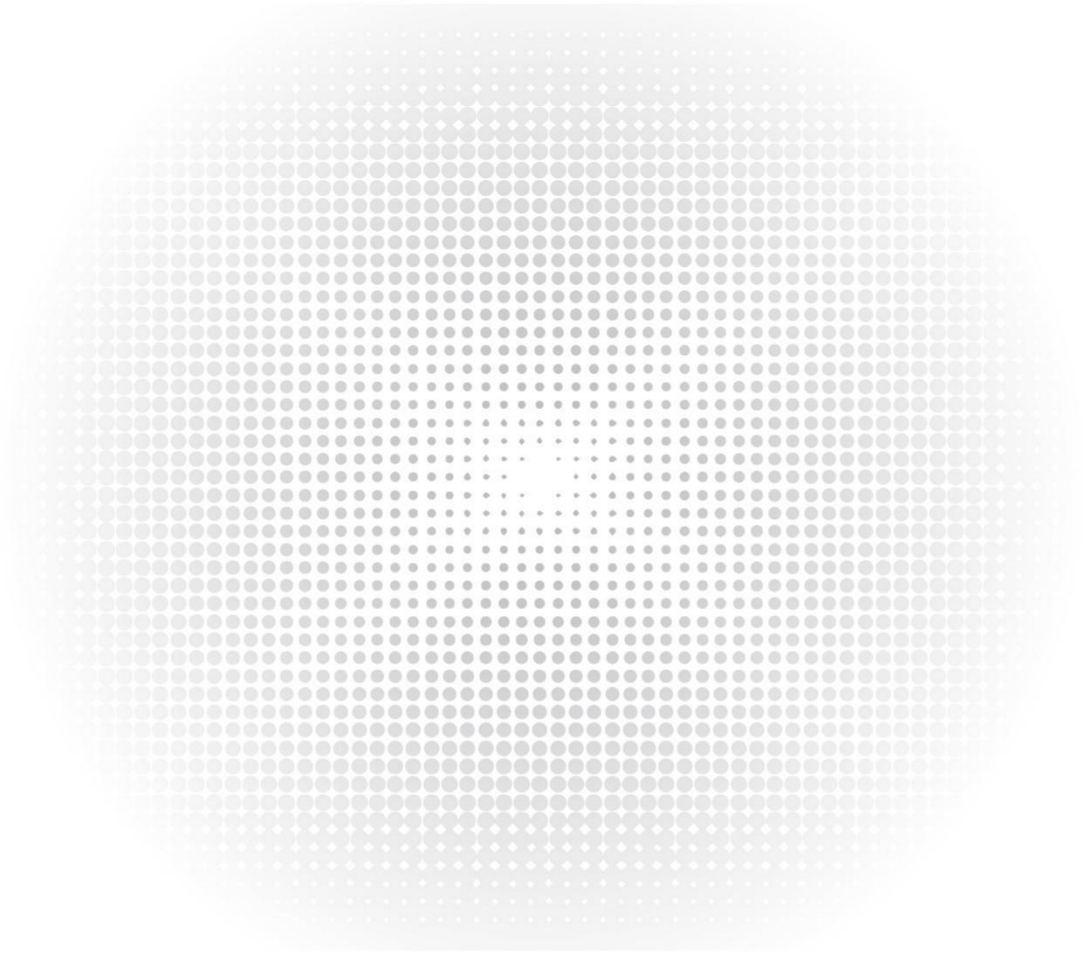
S5900-24S4T2Q Switch ERPS Configuration Guide

Model: S5900-24S4T2Q



CONFIGURATION GUIDE

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Chapter 1 Introduction to Fast Ethernet Ring Protection

1.1 Overview

The fast Ethernet protection protocol is a kind of special link layer protocol, which is used to construct the ring-like Ethernet topology. Ethernet protection protocol blocks a link in the case of complete topology of the ring network to prevent the occurrence of data loops to form a broadcast storm. In the case of link interruption, the protocol quickly recovers the previously blocked link, so that the communication between the nodes of the ring network is restored.
Fast loop protection protocol ensures that data packets can be sent to the correct link when topology changes by controlling the aging of switch MAC address table. generally, the aging time of MAC address in address table is 300 seconds. a ring network protection protocol can control MAC aging of the switch address table in a very short time.
both ring protection protocol and spanning tree protocol are used for link layer topology control. the spanning tree protocol is suitable for various complex networks, which use the hop-by-hop method to propagate network topology changes. The loop protection protocol is dedicated to the loop topology and propagates the topology change information using diffusion method. Therefore, in the ring network, the convergence performance of the ring network protection protocol is better than that of the spanning tree protocol. When the network is in good condition, the time for the ring protection protocol to recover the network communication can be less than 50 milliseconds.

Description: The company's ring network protection protocol supports the configuration of a switch into nodes of multiple physical ring networks to form tangent rings. ring protection protocols do not support intersecting rings with common links.

1.2 ERPS Related Concepts

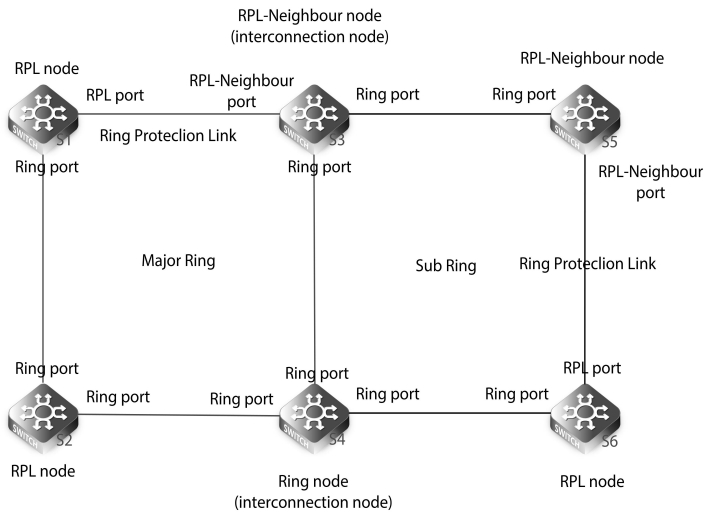

Figure 1: Example of ERPS Ethernet

1.2.1 Ring Network Level

ERPS support multi-loop or hierarchical transport network topology, as shown in Figure 1. The main ring is a complete single ring, and the sub-loop is connected to the main loop (or sub-loop) through two interconnected nodes (interconnection-node), In Figure 1, The red line is the main ring, node S1、 link S1-S2、 node S2、 link S2-S4、 node S4、 link S4-S3、 node S3、 link S3-S1; The blue line is a subring, node S3、 link S3-S5、 node S5、 link S5-S6、 node S6、 link S6-S4、 node but excluding link S4-S3.

1.2.2 Network Node Role

Each switch that forms the ring network is a ring network node. There are four kinds of ring network node roles: RPL protection node, RPL neighbor node, interconnected node (interconnection-node) and common node (Node).one physical link is selected on each single loop as the RPL protection link, one of the two switches directly connected to this link is used as the RPL protection node, the other is used as

the RPL neighbor node, and the remaining other switches are used as ordinary nodes. and the interconnected node (interconnection-node) is the two intersection nodes in which the sub-ring is connected to the main ring (or sub-ring).
the S1 is the RPL protection node in the main loop, as shown in figure 1, S3 is the RPL neighbor node, while the S2 and S4 are the ordinary nodes; in the subloop, the S6 is the RPL protection node, and is connected to the main loop through the interconnected node (interconnection-node).
the node type of the ERPS protocol is mainly determined by the port role, but the node type of the interconnected node (interconnection-node) needs to be determined first when configured. by default, the node is not the interconnected node (interconnection-node).
The function of the ring network node is basically the same: detect the state of the local ring network port and give notice when the link fails. the difference is that RPL protect nodes and RPL neighbor nodes normally block RPL links, while ordinary nodes do not. the interconnected node (interconnection-node) has only one ring-net port connected sub-rings, and the node must also be a node on another main ring (or sub-ring).

1.2.3 Ring Network Port Role

ERPS protocol requires that each node has two ports connected to the ring network, and each port is called the ring network port (Ring Port). furthermore, on each single loop, there exists a ring network port as the ring network protection link (RPL).For interconnected nodes (interconnection-node), although there is only a loop network port connected subloop, there is also a virtual port to detect the connectivity between the two interconnected nodes (interconnection-node), which will be discussed later.
normally, all ring network ports on the ring network except the RPL link are in the forwarding state, RPL the RPL ports of the protection node and the RPL neighbor node are blocked to avoid the loop. RPL protect node and RPL neighbor node to unblock the RPL port in case of ring network link failure to restore network communication.
At one switch, only one RPL port can be configured for each ring node instance.

Description: ERPS protocol supports configuring the aggregation port as a ring network port.

1.2.4 ERPS and CFM

the ring network link is monitored MEP, the ERPS port configuration. the ring network port monitors the state of its ring network link through the down mep; the ring network port of the interconnected node accessing the sub-ring also has to configure the up mep to monitor the connectivity on the main ring, as shown in figure 2.

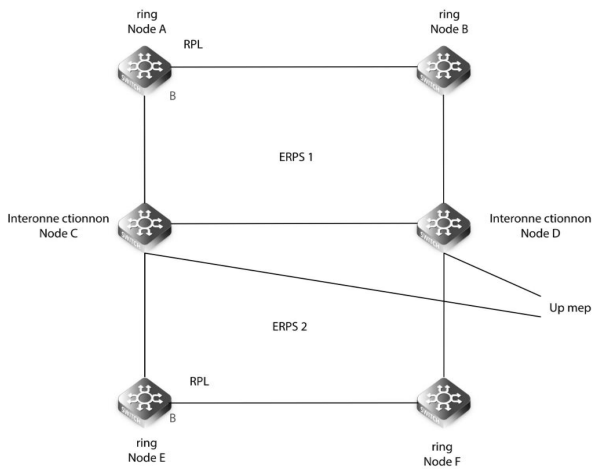

Figure 2: Virtual ports of interconnected nodes configured on Up MEP ports

In figure 2, all ERPS ring network ports are configured down mep, monitor ring network links through down mep, e.g. ring network links are configured on a ring network port C by nodes and nodes respectively down mep later monitored, the link fails or recovers from the failure, sends corresponding notifications to the ERPS control module; at the same time, the down mep is responsible for receiving and sending R-APS messages. up mep is only configured on the ring network port of the interconnected node to access the sub-ring to monitor the connectivity of the main ring. when the direct main ring path of the interconnected node is impassable or the communication is restored, the corresponding notification is sent to the ERPS control module. Moreover, the ring network port for an interconnected node to access a sub-loop is not only configured up mep, because it is also a ring network port, it is also configured down mep..

Description: An interconnected node connects to the ring network port of the sub-ring up mep is configured to monitor the connectivity of the main ring, which is equivalent to the virtual port to monitor the main ring link.

1.2.5 Connectivity Mode Using R-APS Virtual Channels

For a sub-loop, an interconnected node is a node that connects the sub-loop to the rest of the network, as shown in Figure 1. the up mep port of the interconnected node monitors the connectivity of the main ring, which is called the R-APS virtual channel. by R-APS virtual channels, two interconnected nodes can communicate R-APS through the rest of the network.
the sub-loop sends (and receives) R-APS information to the network via R-APS virtual channel, while R-APS information can be transmitted in the network as a data stream. Of course, R-APS information is to be distinguished from ordinary data streams, so different control vlan are used to carry R-APS information for different ERPS ring networks.
Of course, there is also a network state is the interconnection node in connection with the sub-ring and the rest of the network, do not use the R-APS channel, its R-APS channel state is the forwarding state.

1.2.6 R-APS Transmission VLAN

R-APS message is transmitted in a R-APS channel, so set up a VLAN. specifically for the R-APS channel The different nodes set up different VLAN, but for one node, the other nodes set up VLAN can be used as the VLAN. of common data stream transmission
When configuring a R-APS VLAN, if the VLAN is not created, the ERPS system automatically creates the VLAN. for it
the state of the ERPS loop network port in the R-APS channel is consistent with the state of the common data stream, except for the sub-loop that does not use the R-APS virtual channel, because the R-APS channel of the interconnected node on this sub-loop is aborted, so the node on the sub-loop of the R-APS virtual channel is not used, and the state of its R-APS channel is forwarding state.

Description: the VLAN of the MEP port where the ERPS port is located should be consistent with the R-APS transmission.

1.2.7 Return Mode

For some ring networks, the network resources of the link channel in which the data stream is normally transmitted will be better, while the RPL channel is only used for backup, so the return mode is used to return the data stream back to the channel with better network resources when switching and clearing. And some ring networks, the requirements for network resources are not so high, do not need to reverse the recovery immediately back to the original link channel, so the use of non-return mode, but also reduce the number of return switching.
During the return mode operation, when a switch is cleared, the data stream returns to the original channel, blocking the RPL.. The return of the data stream in the case of clearing the fault needs to be used to avoid protection switching in the case of intermittent failure after the WTR timer timeout; while the WTB timer needs to be waited in the case of clearing the manual or forced switching command.and in non-return mode operation, when a switching is cleared, the data stream will still be on the RPL channel as long as the RPL channel is not faulty.

Description: WTR timer and WTB timer only take effect in return mode.

1.3 ERPS Message Type

ERPS type of message used by the protocol is shown in Table 2.1.

ERPS Type of message for the protection protocol

Message Type	Note
Forced Switch (FS)	A loop network node (including a RPL node) notifies the other node after a forced switching command.
Signal Fail (SF)	a ring network node (including RPL nodes) notifies other nodes after detecting local link failure.
Manual Switch (MS)	A loop network node (including RPL nodes) notifies the other nodes after manually switching the command.
No Request (NR)	The ring network node notifies the other nodes after detecting all local ring network link recovery.
No Request, RPL Blocked (NR-RB)	The ring network protection node notifies the other node ring network protection switching recovery.

1.4 ERPS Ring Network Protection Mechanism

1.4.1 Stable State

the loop network protects the node from blocking the RPL port in a stable state and continuously sends NR-RB protocol messages in a configurable period.
All common nodes that receive NR-RB messages set the local ring network port as forwarding state. In stable state, the common node does not send the protocol message.
the period of the NR-RB message sent by the protection node can be modified by send-time node configuration command.

1.4.2 Local Link Failure Processing

Once a loop node detects a local link failure, it first de-blocking the local un-failed port (including RPL port or normal loop port that has not yet entered the forwarding state), then starts sending SF protocol messages and aging the local MAC address table.
All other nodes that receive SF messages first stop sending local messages, then unblock local un-failure ports, and aging address tables.
The link failure node continuously sends the SF message in the configured send-time cycle. During this process, if the port of another node recovers from the failure state, the node sets the recovery port to the forwarding state after receiving the SF message.

1.4.3 Local Link Recovery Processing

If the loop node detects that the local loop network port recovers from the failure state, it will maintain the blocking state of the port and start sending NR messages continuously.
When a node receives a SF message from another node, which indicates that there are other invalid links in the network, the local node stops sending NR message and sets the restored port to forwarding state.
when the local node does not receive a new SF message, after the ring network protection node (RPL node) receives the NR message, the switching recovery timer is started. after the timer timeout, the RPL node re-blocking the RPL port, sending the NR-RB message, and then the address table aging, the network communication is restored to original stable state.

1.4.4 Protection of Switching —— Link Recovery

If the loop node detects that the local loop network port recovers from the failure state, it will maintain the blocking state of the port and start sending NR messages continuously.
When a node receives a SF message from another node, which indicates that there are other invalid links in the network, the local node stops sending NR message and sets the restored port to forwarding state.
When the local node does not receive the new SF message, the link recovery is carried out after the network protection node (RPL node) receives the NR message.but the behavior and function of return mode and non-return mode are inconsistent when link recovery.

1.4.4.1 Return Mode

In return mode, the ring link is restored.RPL node receives the NR message, it will start the switching recovery timer. after the timer timeout, the RPL node re-blocking the RPL port, sending the NR-RB message, and then the address table aging, network communication back to the initial stable state.

1.4.4.2 Non-return Mode

In non-return mode, the ring link does not automatically recover. RPL node does not reply after receiving the NR message, and the other nodes do not do any action after receiving the NR message. Only when RPL node receives the Clear command will the RPL node block the link and continuously send NR RB messages to the two ring network ports, then Flush FDB.Failure node receives NR RB message to unblock the port.Network nodes perform FDB Flush. after receiving NR RB message

1.4.5 Protection Switching —— Manual Switching

When a loop network node receives a manual switching command, it blocks the data channel and the R-APS channel (blocking the port of one data channel and R-APS channel), opens the other loop network ports, and continuously sends MS messages to the two loop network ports, then Flush FDB.. The remaining ring network nodes receive MS messages and open the data flow and R-APS channels through the RPL. The ring network node that sends MS message stops sending MS message after receiving the message.Network nodes perform FDB Flush. after receiving MS message
The above actions completed a manual switching operation, in order to switch normal, there are several points to note:

（1）When a manual switching command already exists in the ring network, the subsequent manual switching commands are invalid. The node receiving the new switching command rejects the new switching command and notifies that manual switching is rejected.

（2）Local nodes that have generated manual switching commands should clear local manual switching commands and send NR messages if MS messages ID different nodes are received. At the same time, the node keeps blocking the ring network port blocked by the previous manual switching command.

（3）A node that has generated a manual switching command should clear the manual switching request and execute a higher priority request if a higher priority local request or message is received.

A node that performs a manual switching command clears the manual switching command after receiving the Clear command. A node keeps blocking the ring network port blocked by the previous manual switching command and continuously sends NR messages to both ring network ports. and the following link recovery, the behavior and function of return mode and non-return mode are inconsistent.

1.4.5.1 Return Mode

In return mode, the ring link is restored. RPL node receives the NR message and starts the WTB timer. WTB the timer timeout, the RPL node blocks the link, sends NR RB messages, and Flush FDB. them The rest of the ring network nodes unblock all non RPL links after receiving the NR RB message, and then Flush FDB.

1.4.5.2 Non-return Mode

In non-return mode, the ring link does not automatically recover. RPL node does not reply after receiving the NR message, and the other nodes do not do any action after receiving the NR message. Only when RPL node receives the Clear command will the RPL node block the link and continuously send NR RB messages to the two ring network ports, then Flush FDB.The rest of the ring network nodes unblock all non RPL links after receiving the NR RB message, and then Flush FDB.

1.4.6 Protection Switching —— Forced Switching

When a loop network node receives a forced switching command, it blocks the data channel and R-APS channel (blocking the port of one data channel and R-APS channel), opens the other loop network ports, and continuously sends FS messages to the two loop network ports, then Flush FDB.. The remaining ring network nodes receive FS messages and open the data flow and R-APS channels through the RPL. The ring network node that sends FS message stops sending FS message after receiving the message. Network nodes perform FDB Flush. after receiving FS message
The above actions completed a forced switching operation, in order to normal switching, there is a point to note:
When a forced switching command already exists in the ring network, subsequent forced switching requests are accepted unless the node has previously accepted a forced switching request. At the same time, the node receiving the new switching command to re-enforce switching operation, blocking ports, sending FS messages and so on. Of course, the execution of multiple forced switching commands will split the ring network, so it should be properly avoided.
A node that performs a mandatory switching command clears the mandatory switching command after receiving the Clear command. A node keeps blocking the ring network port blocked by the previous forced switching command and continuously sends NR messages to both ring network ports. and the following link recovery, the behavior and function of return mode and non-return mode are inconsistent.

1.4.6.1 Return Mode

In return mode, the ring link is restored. RPL node receives the NR message and starts the WTB timer. WTB the timer timeout, the RPL node blocks the link, sends NR RB messages, and Flush FDB. them The rest of the ring network nodes unblock all non RPL links after receiving the NR RB message, and then Flush FDB.

1.4.6.2 Non-return Mode

In non-return mode, the ring link does not automatically recover. RPL node does not reply after receiving the NR message, and the other nodes do not do any action after receiving the NR message. Only when RPL node receives the Clear command will the RPL node block the link and continuously send NR RB messages to the two ring network ports, then Flush FDB.The rest of the ring network nodes unblock all non RPL links after receiving the NR RB message, and then Flush FDB.

1.4.7 Replacement Recovery Process

The ring network protection node (RPL Owner) realizes the ring network switching recovery through timer WTR (wait-to-restore timer) and timer WTB (wait-to-block timer).WTR timer and WTB timer are used to avoid frequent protection switching on the ring network.
WTR timer only takes effect in return mode, in non-return mode, when the ring network is recovered from the protection state, the ring network recovery is not carried out, so there is no need to turn on the WTR timer. while in return mode, after RPL node receives NR messages from other nodes, the WTR timer is started. before the timer time-out, the RPL node maintains the forwarding state of the port and does not send a ring network recovery notification. When RPL node receives SF message again, it indicates that the ring network has not been fully restored, and the node stops WTR timer. WTR the RPL node re-blocking the port after the timer timeout.
WTB timer only works in return mode, used when clearing forced and manual switching commands. When you clear multiple forced switching commands, the WTB timer ensures that a single forced switching command does not cause RPL to duplicate blocking. When a manual switching command is cleared, the WTB timer prevents the RPL node from receiving a closed loop caused by an outdated remote MS request during recovery.
The WTB timer must ensure that there is enough time to receive remote FS、SF and MS messages, so defining the WTB timer is 5 seconds longer than the Guard timer, which is enough for a reporting ring node to send two R-APS messages and allow the entire ring network to confirm situation.

Chapter 2 ERPS Configuration

2.1 ERPS Configuration Notes

Before configuring the ERPS ring protection protocol, read the following notes:
· ERPS port must be hosted on the CFM MEP port, to configure the information for the ERPS port to match the MEP port, the port can be enabled normally after success.
· The default VLAN (or control vlan) for all ring ports needs to be configured to ensure that ERPS messages are forwarded properly.
· The default VLAN and control VLAN of ERPS ring network ports can not be the same as EAPS control VLAN using both protocols. non-reforwardable protocol message in ERPS EAPS control VLAN.
· One port can not act as a ring network port for both ERPS and EAPS protocols.
· ERPS protocol supports configuring physical or aggregate ports as ring network ports. physical ports that have been configured for link aggregation ,802.1 X authentication, or port security are not configurable as ERPS ring network ports.

2.2 ERPS Configuration Tasks

- Configuration of ring network nodes
- Configure loop ports
- View Ring Protection Protocol Status

2.2.1 Configuration of Ring Network Nodes

In global configuration mode, follow the steps below to configure the switch to ERPS nodes.

Command	Objective
Switch_config#erps id	configure the ERPS ring network node instance and enter the node configuration mode. id： ring network example number, range 0-7.
Switch_config_ring#control-vlan value	Must choose.Configure control VLAN. for local nodes no control vlan, remove control VLAN. of local nodes the node must not be changed after normal operation. value： range 1-4094. Default no control-vlan.
Switch_config_ring#interconnection-node	Must choose.configure the local node as an interconnected node. no interconnection-node, configure the local node is not an interconnected node. the node must not be changed after normal operation. default is local node not interconnected node.
Switch_config_ring#raps-virtual-channel	Must choose.Configure local nodes to use R-APS virtual channels. no raps-virtual-channel, configure the local node does not use R-APS virtual channels. the node must not be changed after normal operation. Default uses R-APS virtual channels for local nodes.
Switch_config_ring#revertive-mode	Must choose.configure the return mode of the local node as return mode. no revertive-mode, configure the return mode of the local node as non-return mode. the node must not be changed after normal operation. Default is local node for return mode.
Switch_config_ring#version value	Configure version. of local nodes value： default 1, range 0-2.
Switch_config_ring#wtr-time value	configure the switching recovery timer WTR timeout.

	value： timer timeout, default 20 seconds, range 10-720 seconds.
Switch_config_ring#guard-time value	configure Guard timer timeout time. As a port recovers from the failure state, the Guard timer for a short period of time forbids processing the received protocol message to avoid the wrong protocol action due to receiving the expired message. value： unit 10 ms, default 50, range 1-200.
Switch_config_ring#send-time value	configure protocol message sending cycle. value： message sending cycle, default 5 seconds, range 1-10.
Switch_config_ring#exit	Exit node configuration mode and start node.

Description:

1. Delete the ring network node configuration and the node port configuration using the no erps id command.
2. interconnection-node 、 raps -virtual-channel 、 revertive-mode these three commands are mandatory, they all have default configurations, so when you create a local node, you can omit these commands if you don't need to modify their default values.

2.2.2 Configure Loop Ports

Follow the steps below to configure the switch port as a ring network port.

Command	Objective
Switch_config#interface int er f ace-type interface -number	into port configuration mode. intf -name： port name.
Switch_config_intf#erps id ring-port	Configure the port as a normal ring network port for the specified node. id： ring mesh example number.
Switch_config_intf#erps id rpl	Configure the port as the ring network protection link for the specified node. In the case of automatic discovery of enable, the function of this command is equivalent to modifying the priority value to 0. id： ring mesh example number.
Switch_config_intf#erps id neighbour	the port is configured as the RPL neighbor port of the specified node, and the port must be connected to the RPL port and must be configured as the RPL neighbor port. id： ring mesh example number.
Switch_config_intf#erps id mep [up |down]md md-WORD ma ma-WORD level level-id local local-id remote remote-id	bind ERPS port to MEP port. id： ring mesh example number. md-WORD：MEP maintenance domain information. ma-WORD：MEP maintenance link information. level-id：MEP rating information. local-id：MEP local id information.

	remote-id：MEP distal id information.
Switch_config_intf#exit	exit port configuration mode.

Description:
1. Modify the RPL port to a normal ring network port by no erps id rpl port configuration command.
2. remove the normal ring network port (RPL neighbour port) or RPL port configuration via the no erps id ring-port port configuration command.
3. the erps id ring-port (neighbour) and rpl commands will create a ring network node at the same time when the ring network node is not globally configured.
4. up mep can only be configured in interconnection-node nodes, and interconnection-node can only configure 1 ring network port.

2.2.3 Ring Network Control Command

In monitoring mode, use the following command to control the ring network status.

Command	Objective
erps id ForcedSwitch interface int er f ace-type interface -number	Forced switching of nodes to port int er f ace-type interface -number. id： ring mesh example number.
erps id M anualSwitch interface int er f ace-type interface -number	Change nodes manually to port int er f ace-type interface -number. id： ring mesh example number.
erps id Clear	clears the switching command of the node. id： ring mesh example number.

2.2.4 View Ring Protection Protocol Status

Use the command below to view the ring protection protocol status.

Command	Objective
show erps id	view the summary information of the ring network protection protocol and the ring network port. id： ring mesh example number.
show erps id detail	view the ring network protection protocol and port details.
show erps interface int er f ace-type interface -number	view the status information of the ring network port.

2.3 ERPS Configuration Examples

2.3.1 Configuration Example 1- ERPS Single Ring Configuration

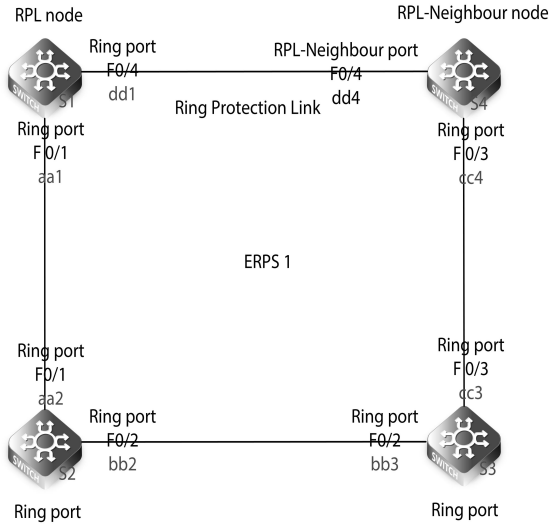

Figure 5.1 ERPS Single Ring Configuration

As shown in Figure 5.1, the S1、S2、S3、S4 configuration is as follows:

2.3.1.1 Configuration switch S1：

Configuration CFM functions:

```
Switch#config
Switch_config#ethernet cfm ENABLE
 Switch_config#ethernet cfm md mdnf STRING a level 4
Switch_config_cfm#ma manf STRING a meps 1-2vlan 2
Switch_config_cfm#exit
Switch_config#ethernet cfm md mdnf STRING d level 4
Switch_config_cfm#ma manf STRING d meps 1,4vlan 2
Switch_config_cfm#exit
Switch_config#interface f0/1
Switch_config_f0/1#ethernet cfm ENABLE
Switch_config_f0/1#ethernet cfm mep add mdnf STRING a manf STRING a mepid 1rmepid 2
Switch_config_f0/1#interface f 0/4
Switch_config_f0/4#ethernet cfm ENABLE
Switch_config_f0/4#ethernet cfm mep add mdnf STRING d manf STRING d mepid 1rmepid 4
```

Network node configuration:

```
Switch_config#erps 1
Switch_config_ring1#control-vlan 2
Switch_config_ring1#exit
Switch_config#
```

Configure common ports:

```
Switch_config#int erface f0/1
Switch_config_f0/1#erps 1ring-port
Switch_config_f0/1#erps 1cfm-disable
Switch_config_f0/1#erps 1mep down md a ma a level 4local 1remote 2
```

Configure RPL ports:

```
Switch_config#int erface f0/4
Switch_config_f0/4#erps 1rpl
```

```
Switch_config_f0/4#erps 1cfm-disable
Switch_config_f0/4#erps 1mep down md d ma d level 4local 1remote 4
```

2.3.1.2 Configuration switch S2：

Configuration CFM functions:

```
Switch#config
Switch_config#ethernet cfm ENABLE
Switch_config#ethernet cfm md mdnf STRING a level 4
Switch_config_cfm#ma manf STRING a meps 1-2vlan 2
Switch_config_cfm#exit
Switch_config#ethernet cfm md mdnf STRING b level 4
Switch_config_cfm#ma manf STRING b meps 2-3vlan 2
Switch_config_cfm#exit
Switch_config#interface f 0/1
Switch_config_f0/1#ethernet cfm ENABLE
Switch_config_f0/1#ethernet cfm mep add mdnf STRING a manf STRING a mepid 2rmepid 1
Switch_config_f0/1#interface f 0/2
Switch_config_f0/2#ethernet cfm ENABLE
Switch_config_f0/2#ethernet cfm mep add mdnf STRING b manf STRING b mepid 2rmepid 3
```

Network node configuration:

```
Switch_config#erps 1
Switch_config_ring1#control-vlan 2
Switch_config_ring1#exit
Switch_config#
```

Configure common ports:

```
Switch_config#int erface f0/1
Switch_config_f0/1#erps 1ring-port
Switch_config_f0/1#erps 1cfm-disable
Switch_config_f0/1#erps 1mep down md a ma a level 4local 2remote 1
Switch_config_f0/1#int erface f0/2
Switch_config_f0/2#erps 1ring-port
Switch_config_f0/2#erps 1cfm-disable
Switch_config_f0/2#erps 1mep down md b ma b level 4local 2remote 3
```

2.3.1.3 Configuration switch S3：

Configuration CFM functions:

```
Switch#config
Switch_config#ethernet cfm ENABLE
Switch_config#ethernet cfm md mdnf STRING b level 4
Switch_config_cfm#ma manf STRING b meps 2-3vlan 2
Switch_config_cfm#exit
Switch_config#ethernet cfm md mdnf STRING c level 4
Switch_config_cfm#ma manf STRING c meps 3-4vlan 2
Switch_config_cfm#exit
Switch_config#interface f0/2
Switch_config_f0/2#ethernet cfm ENABLE
Switch_config_f0/2#ethernet cfm mep add mdnf STRING b manf STRING b mepid 3rmepid 2
Switch_config_f0/2#interface f0/3
```

```
Switch_config_f0/3#ethernet cfm ENABLE
Switch_config_f0/3#ethernet cfm mep add mdnf STRING c manf STRING c mepid 3rmepid 4
```

Network node configuration:

```
Switch_config#erps 1
Switch_config_ring1#control-vlan 2
Switch_config_ring1#exit
Switch_config#
```

Configure common ports:

```
Switch_config#int erface f0/2
Switch_config_f0/2#erps 1ring-port
Switch_config_f0/2#erps 1cfm-disable
Switch_config_f0/2#erps 1mep down md b ma b level 4local 3remote 2
Switch_config_f0/2#int erface f0/3
Switch_config_f0/3#erps 1ring-port
Switch_config_f0/3#erps 1cfm-disable
Switch_config_f0/3#erps 1mep down md c ma c level 4local 3remote 4
```

2.3.1.4 Configuration switch S 4：

Configuration CFM functions:

```
Switch#config
Switch_config#ethernet cfm ENABLE
witch_config#ethernet cfm md mdnf STRING c level 4
Switch_config_cfm#ma manf STRING c meps 3-4vlan 2
Switch_config_cfm#exit
Switch_config#ethernet cfm md mdnf STRING d level 4
Switch_config_cfm#ma manf STRING d meps 1,4vlan 2
Switch_config_cfm#exit
Switch_config#interface f0/3
Switch_config_f0/3#ethernet cfm ENABLE
Switch_config_f0/3#ethernet cfm mep add mdnf STRING c manf STRING c mepid 4rmepid 3
Switch_config_f0/3#interface f0/4
Switch_config_f0/4#ethernet cfm ENABLE
Switch_config_f0/4#ethernet cfm mep add mdnf STRING d manf STRING d mepid 4rmepid 1
```

Network node configuration:

```
Switch_config#erps 1
Switch_config_ring1#control-vlan 2
Switch_config_ring1#exit
Switch_config#
```

Configure common ports:

```
Switch_config#int erface f0/3
Switch_config_f0/3#erps 1ring-port
Switch_config_f0/3#erps 1cfm-disable
Switch_config_f0/3#erps 1mep down md c ma c level 4local 4remote 3
```

Configure RPL neighbor ports:

```
Switch_config#int erface f0/4
Switch_config_f0/4#erps 1neighbour
Switch_config_f0/4#erps 1cfm-disable
Switch_config_f0/4#erps 1mep down md d ma d level 4local 4remote 1
```

2.3.2 Configuration Example 2- ERPS Multi-ring Configuration

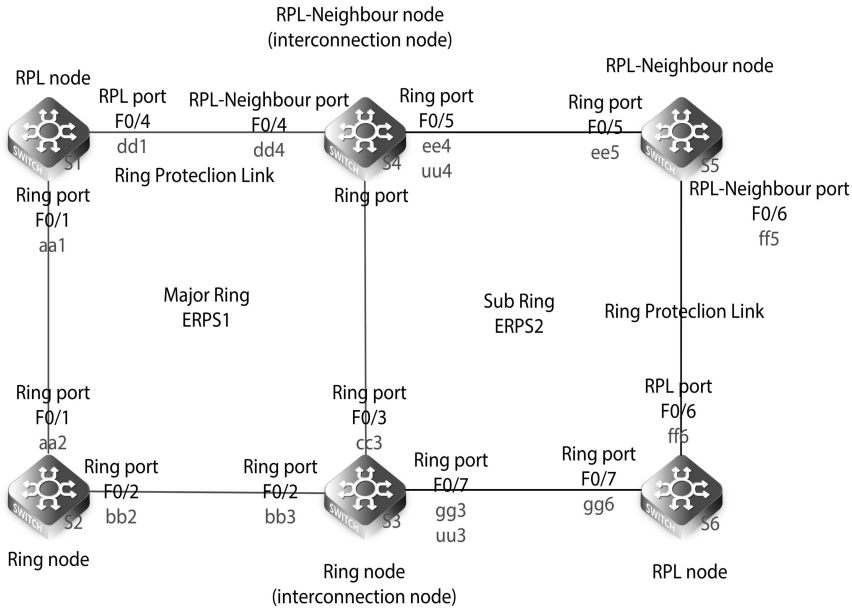

Figure 5.2 ERPS Multi-ring configuration

The interconnection node S 3 and S 4 configurations are as follows, as shown in Figure 5.2, and the other nodes are slightly configured.

2.3.2.1 Configuration switch S 3：

Configuration CFM functions:

```
Switch#config
Switch_config#ethernet cfm ENABLE
Switch_config#ethernet cfm md mdnf STRING mdn b level 4
Switch_config_cfm#ma manf STRING man b meps 2-3vlan 2
Switch_config_cfm#exit
Switch_config#ethernet cfm md mdnf STRING mdn c level 4
Switch_config_cfm#ma manf STRING man c meps 3-4vlan 2
Switch_config_cfm#exit
Switch_config#ethernet cfm md mdnf STRING mdn g level 4
Switch_config_cfm#ma manf STRING man g meps 3,6vlan 3
Switch_config_cfm#exit
Switch_config#ethernet cfm md mdnf STRING mdn u level 5
Switch_config_cfm#ma manf STRING man u meps 3-4vlan 3
Switch_config_cfm#exit
Switch_config#interface f0/2
Switch_config_f0/2#ethernet cfm ENABLE
Switch_config_f0/2#ethernet cfm mep add mdnf STRING mdn b manf STRING man b mepid 3
```

```
Switch_config_f0/2#ethernet cfm mep ENABLE mdnf STRING mdn b manf STRING man b mepid 3
Switch_config_f0/2#ethernet cfm mep cci-ENABLE mdnf STRING mdn b manf STRING man b mepid 3
Switch_config_f0/2#interface f0/3
Switch_config_f0/3#ethernet cfm ENABLE
Switch_config_f0/3#ethernet cfm mep add mdnf STRING mdn c manf STRING man c mepid 3
Switch_config_f0/3#ethernet cfm mep ENABLE mdnf STRING mdn c manf STRING man c mepid 3
Switch_config_f0/3#ethernet cfm mep cci-ENABLE mdnf STRING mdn c manf STRING man c mepid 3
Switch_config_f0/3#interface f0/7
Switch_config_f0/7#ethernet cfm ENABLE
Switch_config_f0/7#ethernet cfm mep add mdnf STRING mdn g manf STRING man g mepid 3
Switch_config_f0/7#ethernet cfm mep ENABLE mdnf STRING mdn g manf STRING man g mepid 3
Switch_config_f0/7#ethernet cfm mep cci-ENABLE mdnf STRING mdn g manf STRING man g mepid 3
Switch_config_f0/7#ethernet cfm mep add mdnf STRING mdn u manf STRING man u mepid 3direction up
Switch_config_f0/7#ethernet cfm mep ENABLE mdnf STRING mdn u manf STRING man u mepid 3
Switch_config_f0/7#ethernet cfm mep cci-ENABLE mdnf STRING mdn u manf STRING man u mepid 3
```

Network node configuration:

```
Switch_config#erps 1
Switch_config_ring1#control-vlan 2
Switch_config_ring1#exit
Switch_config#
Switch_config#erps 2
Switch_config_ring1#control-vlan 3
Switch_config_ring1#interconnection-node
Switch_config_ring1#exit
Switch_config#
```

Configure ERPS1 common ports:

```
Switch_config#int erface f0/2
Switch_config_f0/2#erps 1ring-port
Switch_config_f0/2#erps 1mep down md b ma b level 4local 3remote 2
Switch_config_f0/2#int erface f0/3
Switch_config_f0/3#erps 1ring-port
Switch_config_f0/3#erps 1mep down md c ma c level 4local 3remote 4
```

Configure ERPS2 common ports:

```
Switch_config_f0/3#int erface f0/7
Switch_config_f0/7#erps 2ring-port
Switch_config_f0/7#erps 2mep down md g ma g level 4local 3remote 6
Switch_config_f0/7#erps 2mep down md u ma u level 5local 3remote 4
```

2.3.2.2 Configuration switch S 4：

Configuration CFM functions:

```
Switch#config
Switch_config#ethernet cfm ENABLE
Switch_config#ethernet cfm md mdnf STRING mdn c level 4
Switch_config_cfm#ma manf STRING man c meps 3-4vlan 2
Switch_config_cfm#exit
```

```
Switch_config#ethernet cfm md mdnf STRING mdn d level 4
Switch_config_cfm#ma manf STRING man d meps 1,4vlan 2
Switch_config_cfm#exit
Switch_config#ethernet cfm md mdnf STRING mdn e level 4
Switch_config_cfm#ma manf STRING man e meps 4-5vlan 3
Switch_config_cfm#exit
Switch_config#ethernet cfm md mdnf STRING mdn u level 5
Switch_config_cfm#ma manf STRING man u meps 3-4vlan 3
Switch_config_cfm#exit
Switch_config#interface f0/3
Switch_config_f0/3#ethernet cfm ENABLE
Switch_config_f0/3#ethernet cfm mep add mdnf STRING mdn c manf STRING man c mepid 4
Switch_config_f0/3#ethernet cfm mep ENABLE mdnf STRING mdn c manf STRING man c mepid 4
Switch_config_f0/3#ethernet cfm mep cci-ENABLE mdnf STRING mdn c manf STRING man c mepid 4
Switch_config_f0/3#interface f0/4
Switch_config_f0/4#ethernet cfm ENABLE
Switch_config_f0/4#ethernet cfm mep add mdnf STRING mdn d manf STRING man d mepid 4
Switch_config_f0/4#ethernet cfm mep ENABLE mdnf STRING mdn d manf STRING man d mepid 4
Switch_config_f0/4#ethernet cfm mep cci-ENABLE mdnf STRING mdn d manf STRING man d mepid 4
Switch_config_f0/4#interface f0/5
Switch_config_f0/5#ethernet cfm ENABLE
Switch_config_f0/5#ethernet cfm mep add mdnf STRING mdn e manf STRING man e mepid 4
Switch_config_f0/5#ethernet cfm mep ENABLE mdnf STRING mdn e manf STRING man e mepid 4
Switch_config_f0/5#ethernet cfm mep cci-ENABLE mdnf STRING mdn e manf STRING man e mepid 4
Switch_config_f0/5#ethernet cfm mep add mdnf STRING mdn u manf STRING man u mepid 4direction up
Switch_config_f0/5#ethernet cfm mep ENABLE mdnf STRING mdn u manf STRING man u mepid 4
Switch_config_f0/5#ethernet cfm mep cci-ENABLE mdnf STRING mdn u manf STRING man u mepid 4
```

Network node configuration:

```
Switch_config#erps 1
Switch_config_ring1#control-vlan 2
Switch_config_ring1#exit
Switch_config#
Switch_config#erps 2
Switch_config_ring1#control-vlan 3
Switch_config_ring1#interconnection-node
Switch_config_ring1#exit
Switch_config#
```

Configure ERPS1 common ports:

```
Switch_config#int erface f0/3
Switch_config_f0/3#erps 1ring-port
Switch_config_f0/3#erps 1mep down md c ma c level 4local 4remote 3
```

Configure ERPS1 RPL neighbor ports:

```
Switch_config#int erface f0/4
Switch_config_f0/4#erps 1neighbour
```

```
Switch_config_f0/4#erps 1mep down md d ma d level 4local 4remote 1
```

Configure ERPS2 common ports:

```
Switch_config#int erface f0/5
Switch_config_f0/5#erps 2ring-port
Switch_config_f0/5#erps 2mep down md e ma e level 4local 4remote 5
Switch_config_f0/5#erps 2mep down md u ma u level 5local 4remote 3
```

erps： showing switch S3

```
Switch_config#show erps

Ethernet Ring Protection Switching

Ring1
 RPL Owner Priority Unknown
 Address
 This node is the RPL Owner

 Node ID Priority 32770(priority 32770 id 1)
 Address 00E0.0F81.111B
 Control Vlan 2
 Version 1
 RAPS Virtual Channel：          True
 Revertive Mode：          Revertive
 State Pending WTR False
 Signal Fail False Sending NR
 WTR time 0/20sec WTB time 0/6sec
 Guard time 0/500ms Send time 1/5sec

Interface Role State Status MEP Role
--------------------------------------------------------------------------
 F0/2Ring-Port BLK Link-down DOWN-MEP
 F0/3Ring-Port FWD Link-down DOWN-MEP

Ring2
 RPL Owner Priority Unknown
 Address

 Node ID Priority 32770(priority 32768 id 2)
 Address 00E0.0F81.111B
 Control Vlan 3
 Version 1
 This node is the interconnection node
 RAPS Virtual Channel：          True
 Revertive Mode：          Revertive
 State Protection
```

```
 Signal Fail False Sending SF
 WTR time 0/20sec WTB time 0/6sec
 Guard time 0/500ms Send time 1/5sec

Interface Role State Status MEP Role
--------------------------------------------------------------------------------
F0/7Ring-Port FWD Link-up DOWN-MEP
F0/7(up) Ring-Port BLK Link-down UP-MEP
```

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