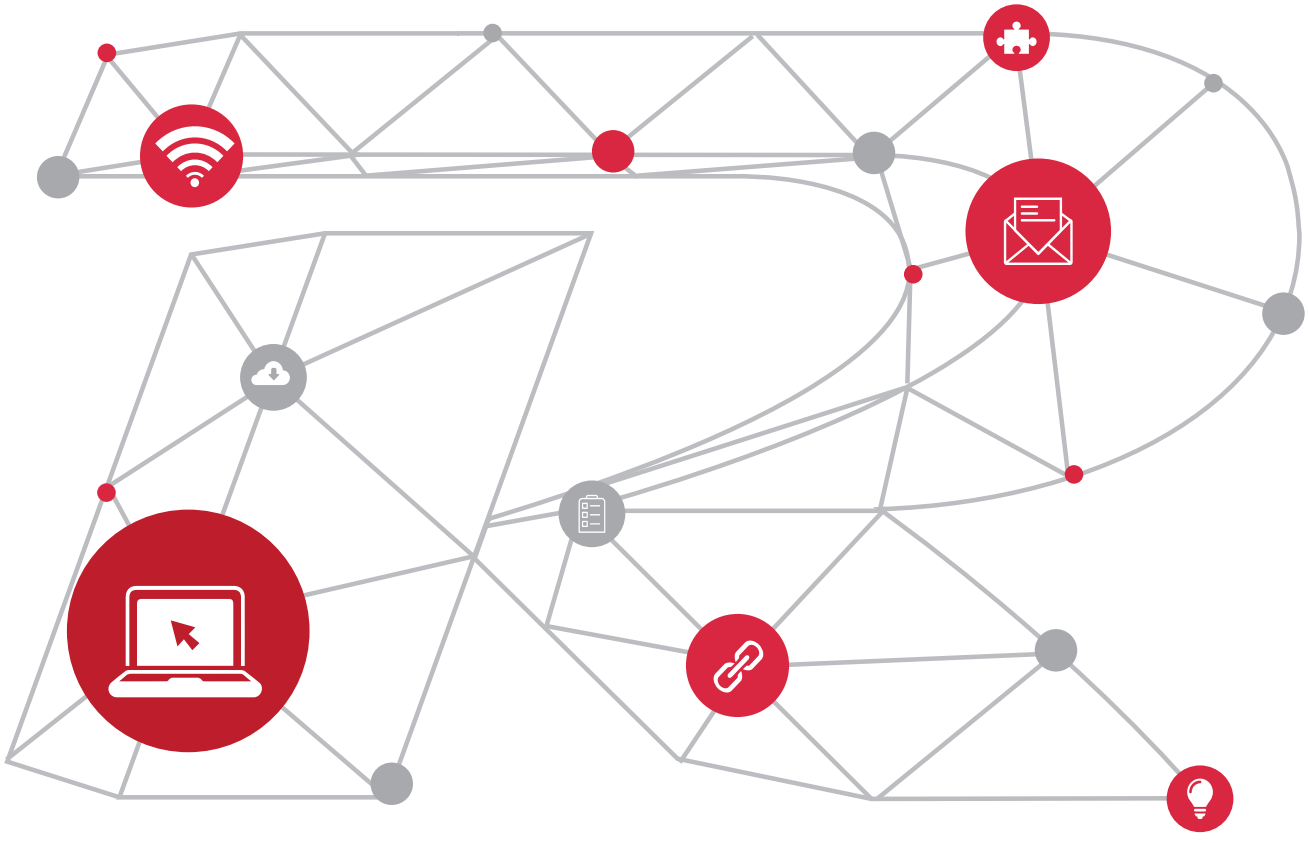
Ruijie Ethernet Ring Protection Switching

White Paper



Contents

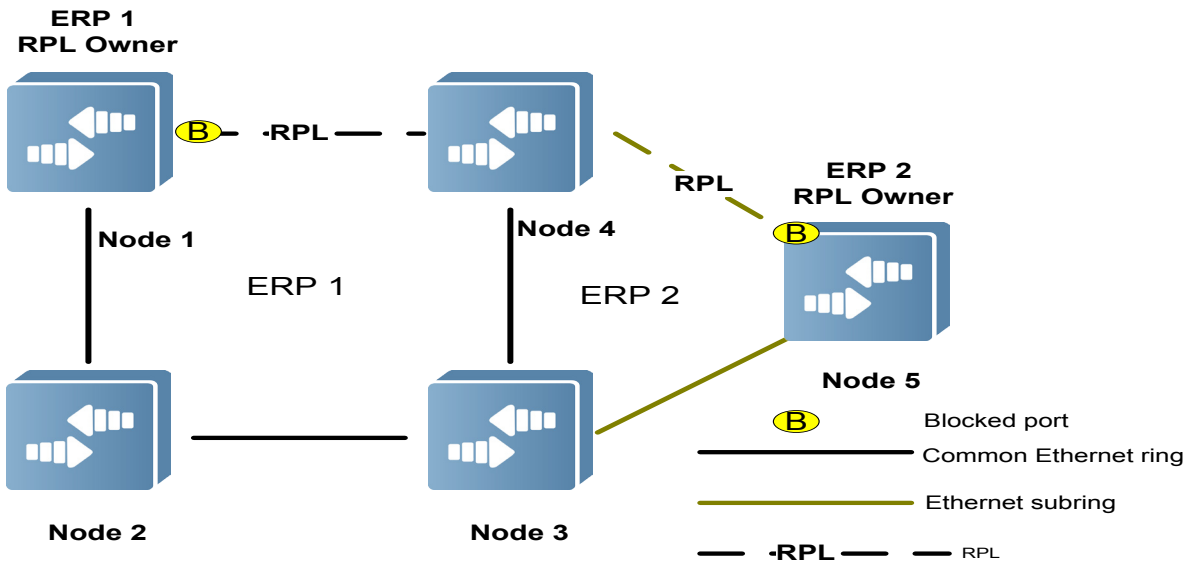
Introduction

This document describes the Ethernet Ring Protection Switching (ERPS) feature and configuration guidance to ensure network reliability.

ERPS, also known as G.8032, is a ring protection protocol developed by ITU. It is a data link layer protocol designed for Ethernet rings. ERPS can prevent broadcast storms caused by data loops when an Ethernet ring is idle and can rapidly recover the communication between nodes in the event that a link is disconnected in the Ethernet ring.

Concepts

Figure 1 ERPS Topology



• Ethernet Ring

Ethernet rings include common Ethernet rings and Ethernet subrings:

* **Common Ethernet ring: an Ethernet topology connected as a ring, such as ERP1 in Figure 1.**

* **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, such as ERP2 in Figure 1.**

An Ethernet ring (regardless of common Ethernet rings or Ethernet subrings) can be in one of the following states:

* **Idle state: All the physical links in the Ethernet ring are connected.**

* **Protection state: Some physical links in the Ethernet ring are disconnected.**

• Node

Each device in an Ethernet ring is a node. ERPS has the following node roles for a specific Ethernet ring:

* **Ring protection link (RPL) owner node: a node that is adjacent to an RPL and is used to block RPLs to prevent loops on a network when the Ethernet ring is in the idle state. Each Ethernet ring has only one RPL owner node. (There may be more than one RPL owner node when multiple ERP rings are configured in an Ethernet ring in load balancing mode.) In Figure 1, Node1 functions as the RPL owner node of ERP1 and Node5 functions as the RPL owner node of ERP2.**

* **Non-RPL owner node: nodes other than the RPL owner node in an Ethernet ring. In Figure 1, nodes except Node1 and Node5 are called non-RPL owner nodes of their respective rings.**

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

* **Intersecting node: belongs to multiple rings at the same time in intersecting Ethernet rings. In Figure 1, Node3 and Node4 are intersecting nodes.**

* **Non-intersecting node: belongs to only one Ethernet ring in intersecting Ethernet rings. In Figure 1, nodes except Node3 and Node4 are non-intersecting nodes.**

• Link and Channel

* RPL: Only one RPL exists in each Ethernet ring. When an Ethernet ring is in the idle state, the RPL is blocked and does not forward data packets to prevent loops. In Figure 1, the link between Node1 and Node4 is the RPL of ERP1 and Node1 blocks the RPL port; the link between Node4 and Node5 is the RPL of ERP2 and Node5 blocks the RPL port.

* Subring link: belongs to a subring in intersecting rings and is controlled by the subring. In Figure 1, assume that ERP1 is a common Ethernet ring and ERP2 is an Ethernet subring. The link between Node4 and Node5 and the link between Node3 and Node5 are links of ERP2, and the other links belong to ERP1. Note that the link between Node3 and Node4 belong to ERP1, it does not belong to ERP2 and is not controlled by ERP2.

* Ring Automatic Protection Switching (R-APS) virtual channel: transmits subring protocol packets between intersecting nodes in intersecting rings but does not belong to the subring. In Figure 1, Node1 blocks the RPL and protocol packets of ERP2 are transmitted through the direct link between Node3 and Node4 in ERP1. The link between Node3 and Node4 is the R-APS virtual channel of ERP2.

• VLAN

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

* R-APS VLAN: a VLAN dedicated to transmitting ERPS protocol packets. On a device, the ports accessing an ERP ring belong to the R-APS VLAN and only such ports can join the R-APS VLAN. R-APS VLANs of different ERP rings must be different. IP address configuration is prohibited on the R-APS VLAN interfaces.

* Data VLAN: A VLAN dedicated to transmitting data packets. Both ERP ports and non-ERP ports can be assigned to a data VLAN.

• R-APS Messages

The following table describes the types and functions of ERPS protocol packets (also called R-APS messages).

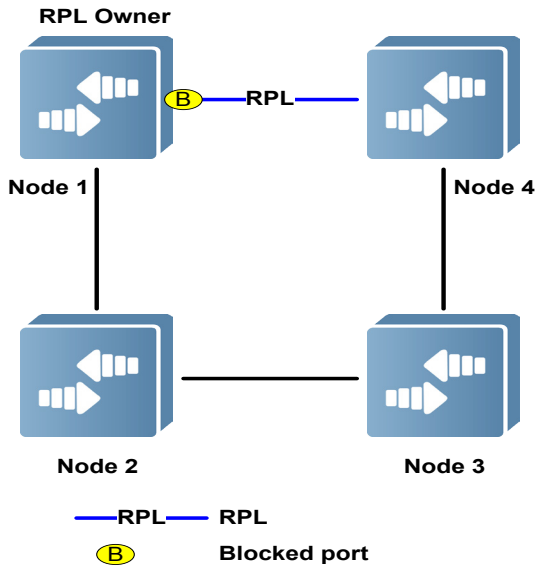
Message Type	Description
Signal Fail (SF)	When the link of a node is down, the node sends the SF messages to notify other nodes of its link failure.
No Request (NR)	When the failed link is restored, the node sends the NR messages to notify the RPL owner node of its link recovery.
No Request, RPL Blocked (NR, RB)	When all nodes in an ERP ring function properly, the RPL owner node sends the (NR, RB) messages periodically.
Flush	CCKM with LEAP

Technical Principle

• Normal State

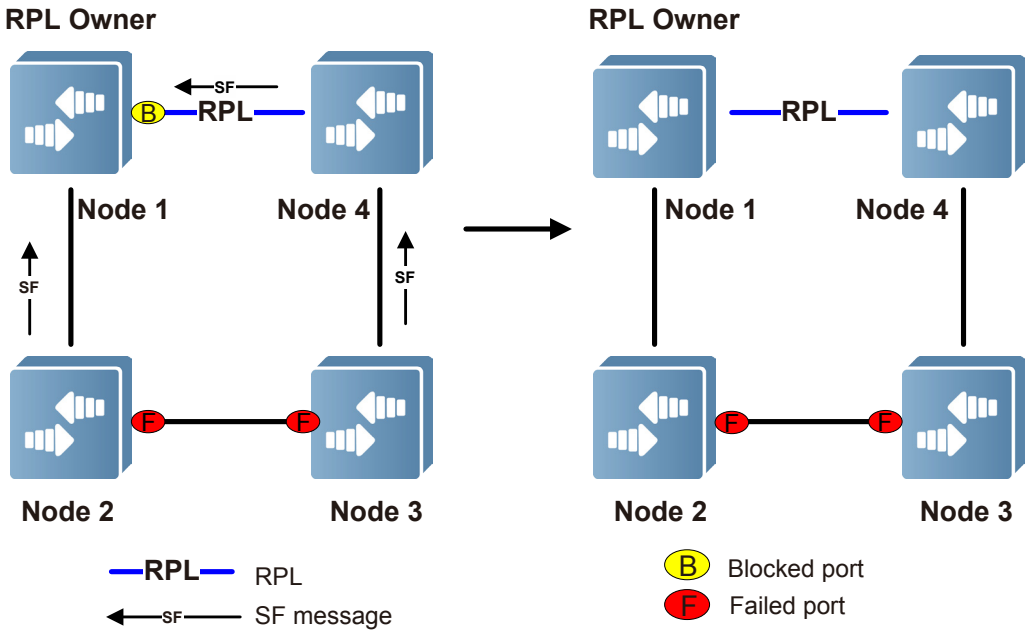
1. All nodes in a physical topology are connected to as rings.
2. ERPS blocks RPLs to prohibit formation of loops. In Figure 2, the link between Node1 and Node4 is an RPL.
3. ERPS detects failures on each link between adjacent nodes.

Figure 2 Ethernet Ring Network in the Normal State



• Link Failure

Figure 3 Ethernet Ring Protection Switching in a Link Failure

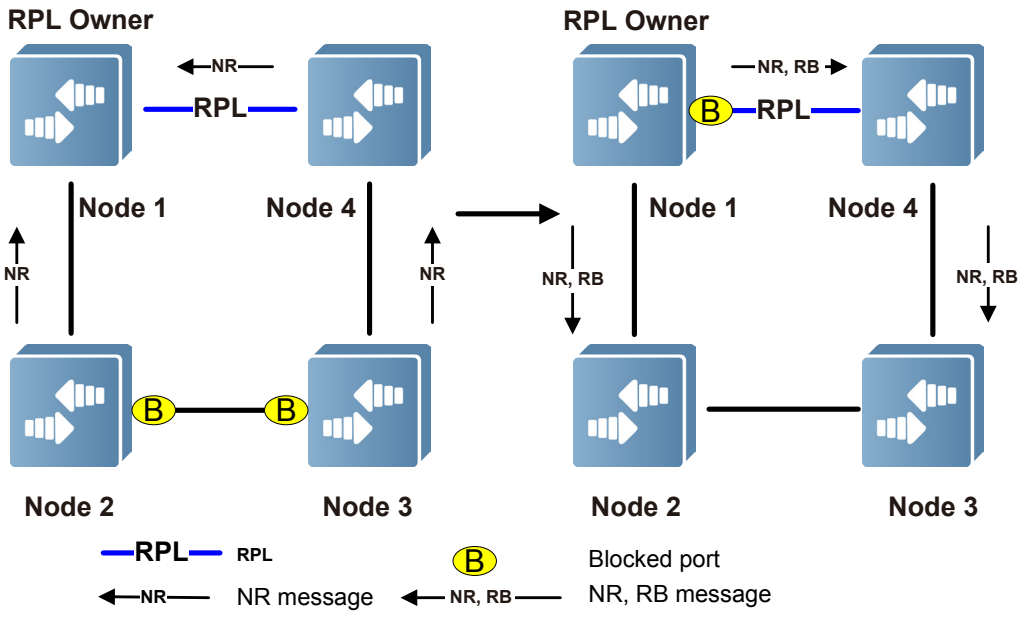


1. The nodes adjacent to a failed link block the failed link and send the R-APS(SF) message to notify other nodes in the ring of the link failure. In Figure 3, the link between Node2 and Node3 fails. After the holdoff timer expires, Node2 and Node3 block the failed link and send the R-APS(SF) message to other nodes in the ring.

2. The R-APS(SF) message 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

Figure 4 Ethernet Ring Protection Switching in Link Failure Recovery



1. When a failed link is restored, nodes adjacent to the link are still blocked and they send the R-APS(NR) message, indicating that no local failure exists.
2. After the guard timer expires and the RPL owner node receives the first R-APS(NR) message, the RPL owner node starts the WTR timer.
3. After the WTR timer expires, the RPL owner node blocks the RPL and sends the R-APS(NR, RB) message.
4. After receiving the R-APS(NR, RB) message, other nodes update their MAC address entries and ARP/ND entries, and the nodes that send the R-APS(NR) message stop periodic transmission of the message and unblock the blocked ports. The ring network is restored to the normal state.

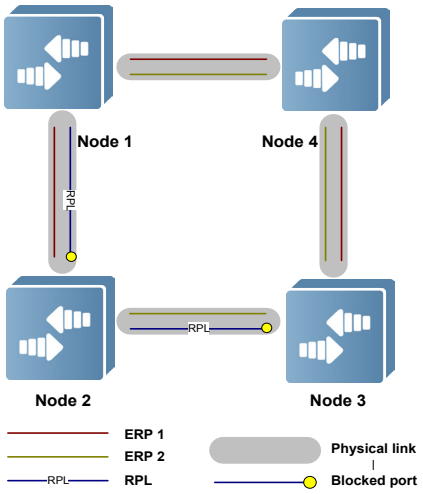
Characteristics of Ruijie ERPS Technology

• ERPS Load Balancing

On a ring network, multiple Ethernet rings can be configured to send traffic of different VLANs (called protected VLANs) so that the data traffic of different VLANs is transmitted by different topologies for load balancing.

In Figure 5, two Ethernet rings are configured with different protected VLANs on the ring network. Node2 is the RPL owner node of ERP1 and Node3 is RPL owner node of ERP2. With such configurations, data from different VLANs can be transmitted on different links for load balancing in a single ring network.

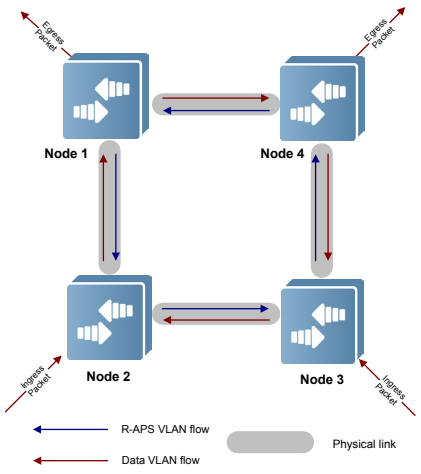
Figure 5 Load Balancing Topology of ERPS



• High Security

ERP rings support two types of VLAN: R-APS VLAN and data VLAN. R-APS VLANs transmit only ERPS protocol packets, and ERP rings process protocol packets only from the R-APS VLANs. ERP rings do not process protocol attack packets from any data VLAN, thereby enhancing the ERP ring's security.

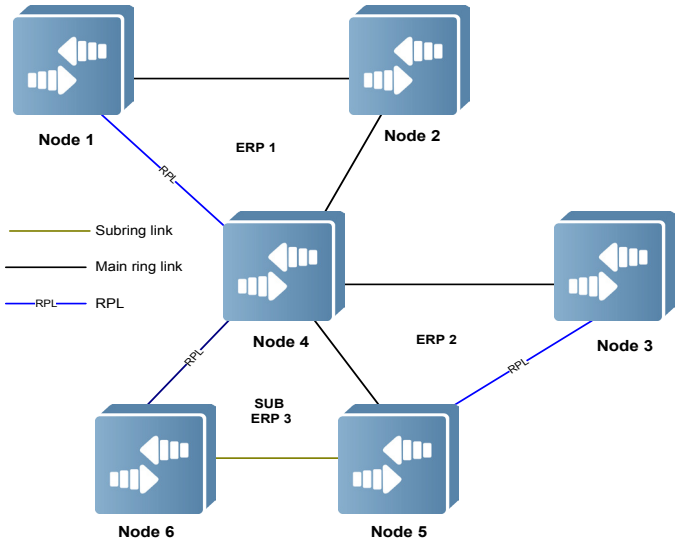
Figure 6 Data VLAN Flow and R-APS VLAN Flow



• Intersection and Tangency of Multiple Rings

In Figure 7, ERPS allows adding a node (Node4) to multiple rings in tangent or intersecting mode, thereby greatly enhancing the networking flexibility.

Figure 7 Intersection and Tangency Topology of Multiple Rings



Typical Application

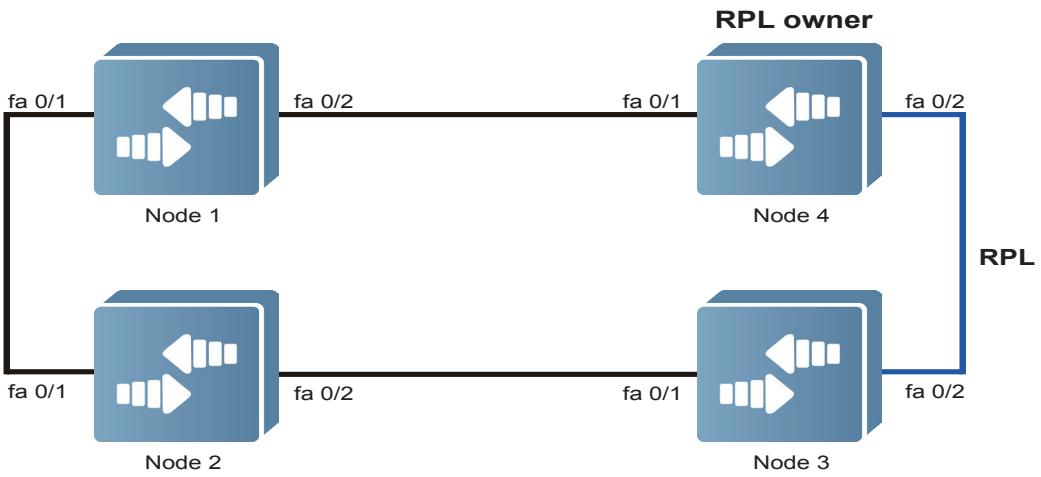
• Application Scheme of a Single Ring

Networking Requirements

ERPS needs to be configured to prevent broadcast storms caused by data loops when the Ethernet ring is complete, and to rapidly recover the communication between nodes when a link is disconnected in the Ethernet ring.

Networking Topology

Figure 8 Single-ring Topology



Configuration Key Points

* **Node1, Node2, Node3, and Node4 form a single ring.**
* **The R-APS VLAN of the ring is 4093.**
* **Node4 is the RPL owner node and the link between Node3 and Node4 is an RPL.**

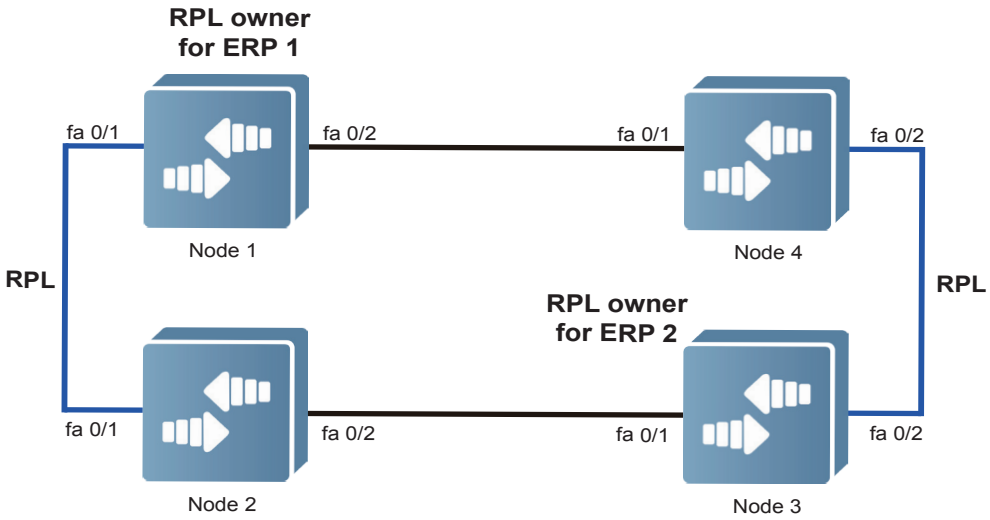
• Application Scheme of Load Balancing

Networking Requirements

The bandwidth of all links (including RPL) on an Ethernet ring network needs to be fully utilized when the Ethernet ring network functions properly.

Networking Topology

Figure 9 Load Balancing Topology



Configuration Key Points

* **Node1, Node2, Node3, and Node4 form a topology ring. The topology ring consists of two Ethernet rings: ERP1 and ERP2.**
* **Node1 is the RPL owner node and the link between Node1 and Node2 is the RPL of ERP1. Node3 is the RPL owner node and the link between Node3 and Node4 is the RPL of ERP2.**
* **The R-APS VLAN of ERP1 is 100 and the protected data VLANs are 1-99 and 101-2000. The R-APS VLAN of ERP2 is 4093 and the protected data VLANs are 2001-4092 and 4094.**
*

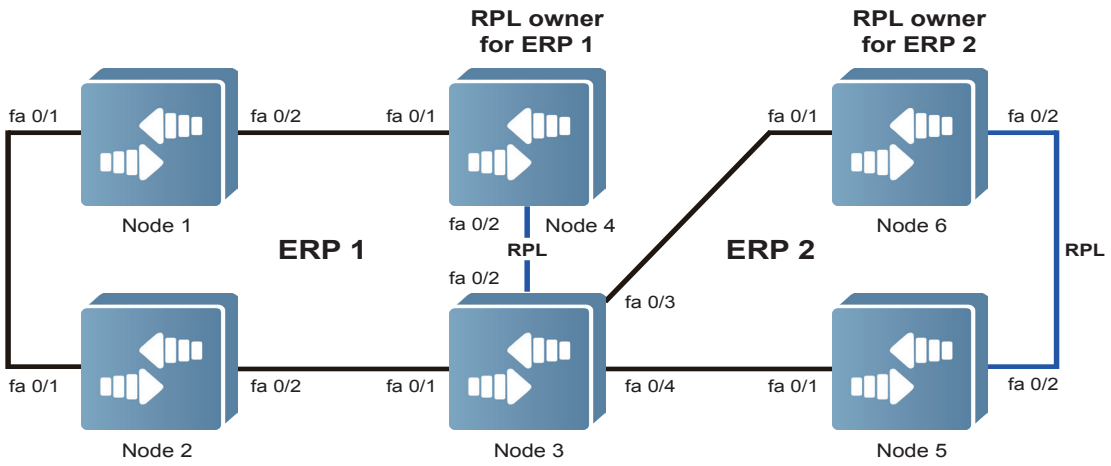
• Application Scheme of Tangent Rings

Networking Requirements

Network nodes need to be fully utilized and a node is allowed to be added to multiple ERPs in tangent mode.

Networking Topology

Figure 10 ERPS Tangent Ring Topology



Configuration Key Points

*** Node1, Node2, Node3, and Node4 form a common Ethernet ring: ERP1, and Node3, Node5, and Node6 form another common Ethernet ring: ERP2.**

*** The R-APS VLAN of ERP1 is 4093 and the R-APS VLAN of ERP2 is 100.**

*** Node4 is the RPL owner node and the link between Node3 and Node4 is the RPL of ERP1. Node6 is the RPL owner node and the link between Node5 and Node6 is the RPL of ERP2.**

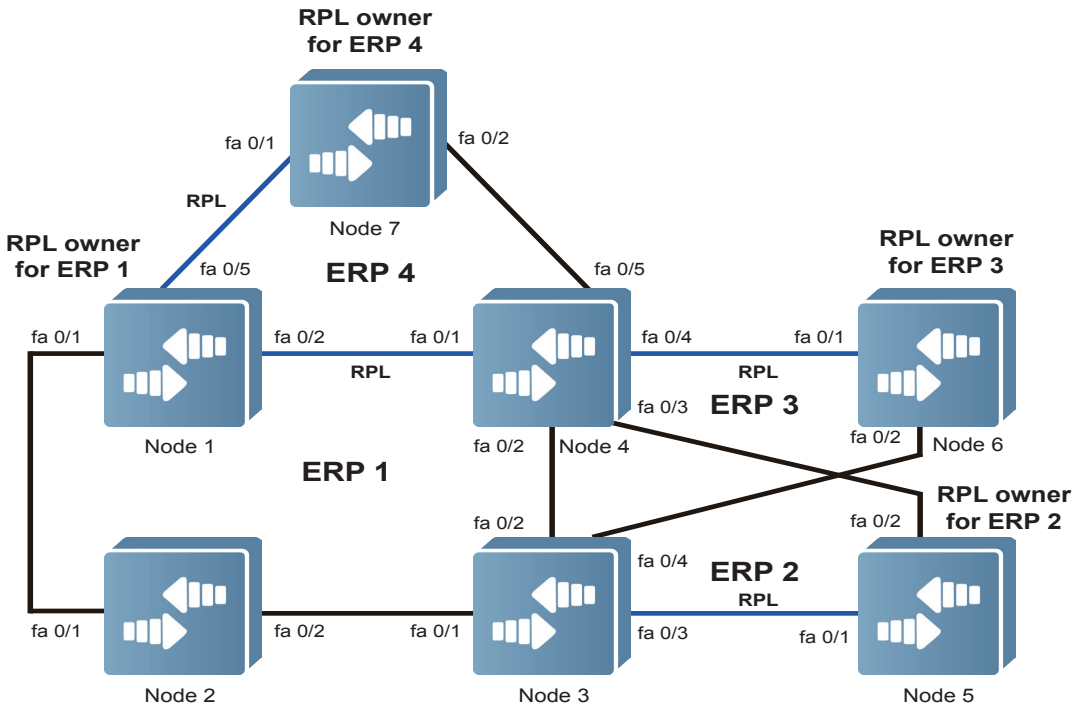
• Application Scheme of Intersecting Rings

Networking Requirements

Network nodes need to be fully utilized and a node is allowed to be added to multiple ERPs in intersecting mode.

Networking Topology

Figure 11 ERPS Intersecting Ring Topology



Configuration Key Points

* Node1, Node2, Node3, and Node4 form a common Ethernet ring: ERP1; Node3, Node5, and Node4 form an Ethernet subring: ERP2; Node3, Node6, and Node4 form an Ethernet subring: ERP3; Node1, Node4, and Node7 form an Ethernet subring: ERP4.

* The R-APS VLANs of ERP1, ERP2, ERP3, and ERP4 are 4093, 100, 200, and 300 respectively.

* Node4 is the RPL owner node and the link between Node1 and Node4 is the RPL of ERP1. Node5 is the RPL owner node and the link between Node3 and Node5 is the RPL of ERP2. Node6 is the RPL owner node and the link between Node4 and Node6 is the RPL of ERP3. Node7 is the RPL owner node and the link between Node7 and Node1 is the RPL of ERP4.

Performance of a Ring Network Composed of RG-IS2700G

- ERPS Performance of a Ring Network Composed of RG-IS2700G

Figure 12

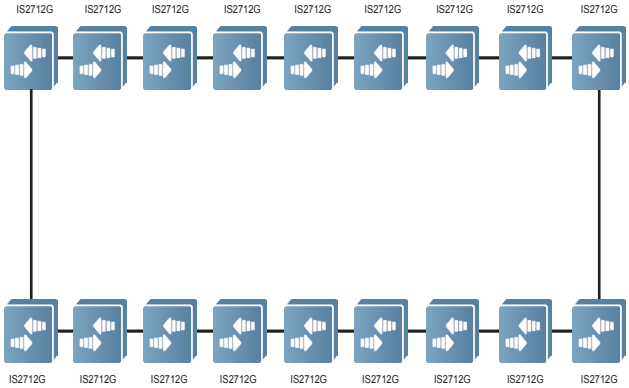
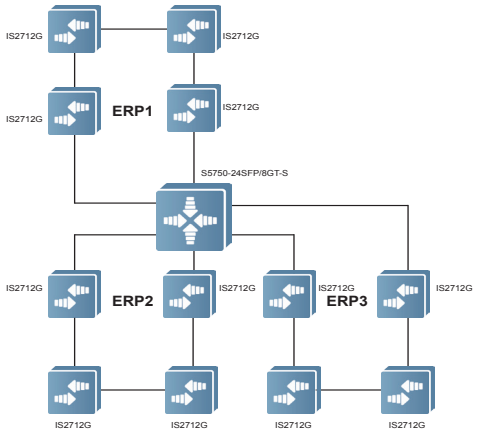


Figure 13



A ring supports up to **50** devices. The convergence time is smaller than **15** ms.

Multiple rings are supported and each device supports up to **12** rings. The convergence time is smaller than **20** ms.

Conclusion

ERPS provides a fast Ethernet ring protection mechanism. When a failure occurs on a ring network, ERPS is capable of rapidly recovering network transmission, thereby ensuring high availability and high reliability of industrial switches in the ring topology.

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