

User Manual

ERPS

Ethernet Ring Protection Switching

ITU-T G.8032

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WoMaster

Ethernet Ring Protection Switching ITU-T G.8032

User Manual

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About This Manual

This user manual is intended to guide a professional installer to configure the ERPS. It includes procedures to assist you in avoiding unforeseen problems.



NOTE:

Only qualified and trained personnel should be involved with installation, inspection, and repairs of this switch.

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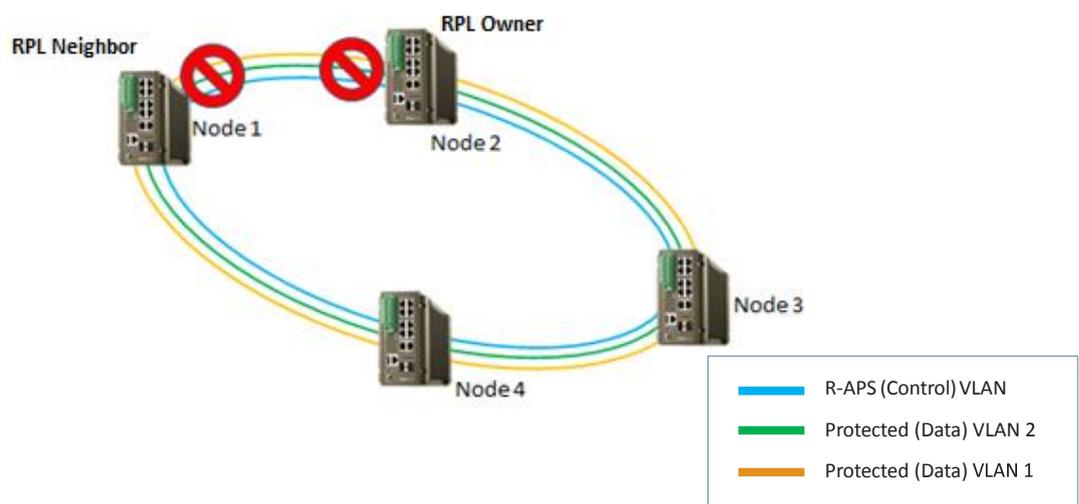
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1. ERPS

1.1 OVERVIEW

The ITU-T G.8032 Ethernet Ring Protection Switching feature implements protection switching mechanisms for Ethernet layer ring topologies. This feature uses the G.8032 Ethernet Ring Protection (ERP) protocol, defined in ITU-T G.8032, to provide protection for Ethernet traffic in a ring topology, while ensuring that no loops occur within the ring. The loops are prevented by blocking traffic on either a predetermined link or a failed link.

The ERPS is a mechanisms and a protocol for Ethernet layer network rings. Ethernet rings can provide wide-area multipoint connectivity more economically due to their reduced number of links. The mechanisms and protocol defined in this standard allow Ethernet networks to achieve highly reliable and stable protection; also preventing loops, which would fatally affect network operation and service availability.



1.2 BASIC CONCEPT

ERPS mainly includes ERPS ring, node, port role and port status.

- **ERPS Instance**

ERPS instance is formed by the same instance ID, control VLAN and interconnected switches.

- **Control Channel**

Control channel is the transmission VLAN of ERPS protocol, and the protocol packet will carry corresponding VLAN tag.

- **RPL**

RPL (Ring Protection Link), Link designated by mechanism that is blocked during Idle state to prevent loop on

Bridged ring

- **ERPS ring**

ERPS ring is ERPS basic unit. It composed by a set of the same control VLAN and the interlinked L2 switch equipment.

- **Node**

The L2 switch equipment added in ERPS ring are called nodes. Each node cannot be added to more than two ports in the same ERPS ring. The nodes are divided into RPL Owner, Neighbor, and Ring Node.

- **Port Role**

In ERPS, port roles include: RPL Owner, Neighbor and Common:

1) RPL Owner: An ERPS ring has only one RPL Owner port configured by the user and it prevents loops in the ERPS ring via blocking the RPL Owner port. The node that owns the RPL Owner port becomes the RPL Owner node.

2) RPL Neighbour: An ERPS ring has only one RPL Neighbor port configured by the user and it must be a port connected to the RPL Owner port. If the network is normal, it will block together with the RPL Owner port to prevent loops in the ERPS ring. The node with the RPL Neighbor port becomes the RPL Neighbor node.

3) Ring Node: The common port. The ports except RPL owner and Neighbor port are Ring Node ports. If the node has only the common port, this node will become the Ring node.

- **Port Status**

In the ERPS ring, the port status of the ERPS protocol is divided into two types.

1) Forwarding: In Forwarding status, the port forwards user traffic and receives / forwards R-APS packets. Moreover, it forwards R-APS packets from other nodes.

2) Blocking: In the Blocking status, a port in the blocking status does not participate in frame forwarding and also discards frames received from the attached network segment.

- **Work Mode: ERPS operating mode**

Work mode includes: revertive and non-revertive.

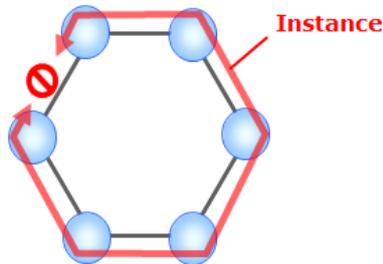
1) **Revertive**: When the link fails, the RPL link is in the release protection state and the RPL link is re-protected after the faulty link is restored to prevent loops.

2) **Non-revertive**: After the fault is rectified, the faulty node remains faulty (without entering Forwarding) and the RPL link remains in the release protection state.

1.3 HOW ERPS WORKS

1.3.1 ERPS COMPONENTS

ERPS Instances



Instance is a logical ring that running over physical ring, that composed of a set of VLANs. Each node contains an instance. It is made up of:

- two ERPS ring ports
- a Control VLAN that carries Ring-Automatic Protection Switching (R-APS) messages
- one or more Protected Data VLANs that the instance protects when the ring fails.

ERPS ring ports

These are the physical interface ports or interface Link Aggregation Groups (LAGs) that are used by the instance. In the major ring case, all nodes are required to have two ERPS ring ports. Traditionally, these are referred to as East and West ring ports.

R-APS channel VLAN (Control VLAN)

R-APS messages are carried over a channel. In G.8032, this channel is implemented using a VLAN. Each ERP instance uses a tag-based VLAN called the raps-channel for sending and receiving R-APS messages. All the nodes in the ring are required to use this raps-channel VLAN, and this VLAN must have the ERP ring ports as members. The function of the R-APS VLAN is to monitor the ring and maintain its operational functions. The R-APS VLAN carries no user data. R-APS messages flow through the ring to control its protection switching behavior.

Each node along the path will receive the R-APS message on the raps-channel VLAN and copy it for local processing. It will also attempt to forward the original version at L2 switching speed to its other ring port. If the raps-channel VLAN on the other ring port is blocked, then the R-APS message is not forwarded to the other nodes.

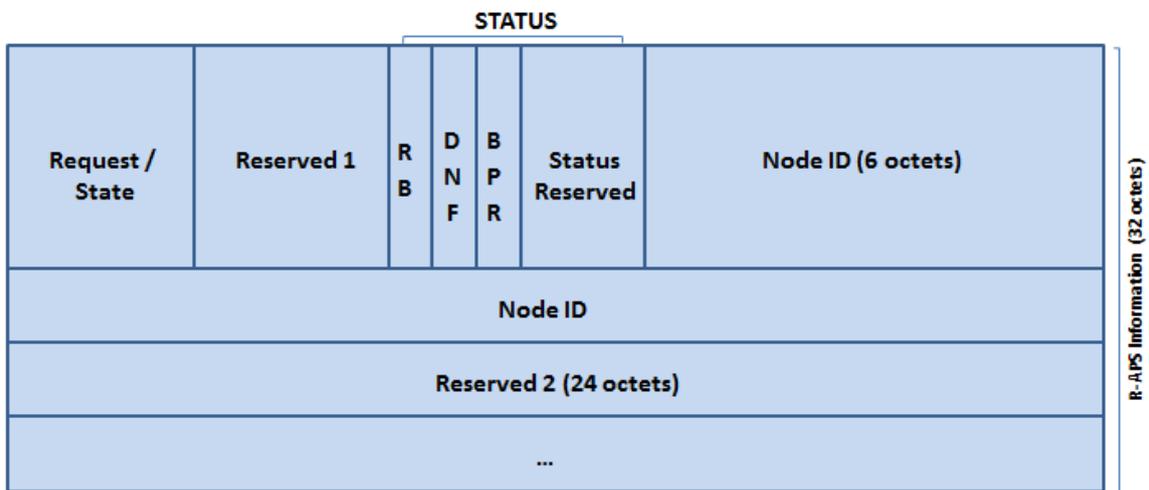
The raps-channel control VLAN is blocked from being forwarded to other nodes at the same place the protected data

VLANs are blocked from being forwarded.

NOTE: Sub-rings without a virtual-channel are an exception which is discussed below. In this case, the raps-channel VLAN is not blocked from being forwarded even though the protected data VLANs are blocked.

The node that actually generates the R-APS messages will always send over both of its ring ports regardless of whether or not the raps-channel VLAN is being blocked on its ring ports. Similarly, R-APS messages will be received and processed regardless of whether or not the raps-channel VLAN is being blocked on its ring ports.

Below is the R-APS Message Format.



Specific Information (32 octets) is below:

Request/Status(4bits) – ‘1101’ = FS , ‘1110’ = Event, ‘1011’ = SF, ‘0111’ = MS, ‘0000’ = NR, Other = Future

Status – RB (1bit) – Set when RPL is blocked (used by RPL Owner in NR)

Status – DNF (1bit) – Set when FDB Flush is not necessary

NodeID (6octets) – MAC address of message source node (Informational)

Reserved1(4bits), **Status Reserved**(6bits), **Reserved2**(24octets)

Data-traffic VLAN (Protected Data VLAN)

Each ERP instance protects one or more data carrying VLANs (called data-traffic). All the nodes in the ring are required to have the same protected VLANs. The protected VLANs should have the ERPS ring ports as members.

RPL-Owner

The RPL provides the blocking of traffic under normal operating conditions, thus preventing loops. The RPL consists

of an Owner on one end, and a Neighbor on the other end. It is the Owner that provides the main control for protection switching. Under normal operating conditions both ends of the RPL perform a block. However, the Owner generates R-APS No Request RPL-Blocked (NR,RB) messages continuously and is the one in charge of the RPL's blocking and forwarding states.

Under normal operation, when there are no failures, the RPL-Owner generates R-APS (NR,RB) messages. It periodically sends these, every 5 seconds, over both of its ring ports. These messages indicate which of its East or West ring ports is being blocked. Each node along the way receives the R-APS, recording the Node-id and Block Port Reference (BPR) in the message. This is used to detect a topology change.

NOTE: Configuring a G.8032 ring without an RPL-Owner is never recommended. While the G.8032 protocol can operate without an RPL-Owner, as other nodes in the ring are allowed to send R-APS messages and block traffic under both normal and failed conditions, the RPL-Owner provides predictability as to where the ring block will occur under normal conditions. The RPL-Owner is also needed for revertive operations.

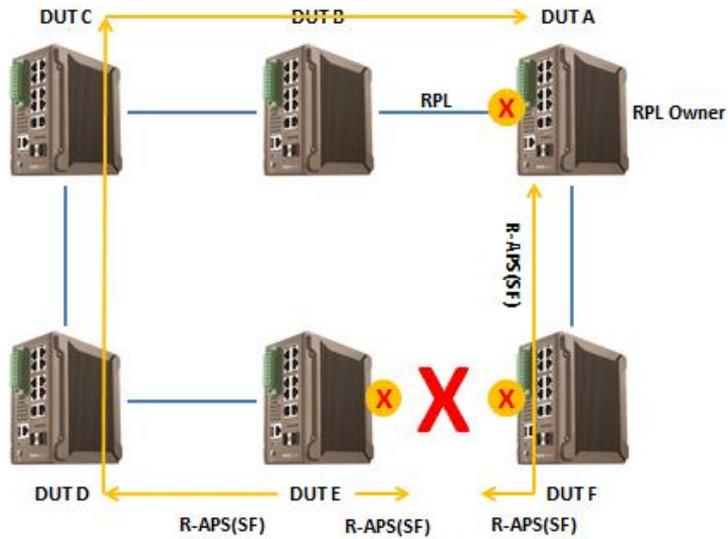
1.3.2 RING FAILURE

When a failure is detected on a ring port, known as a Signal Fail (SF), the node detecting the failure will generate an R-APS (SF) message. This message notifies the other nodes on the ring of the failure, causing a protection switch to occur. The RPL nodes remove the block on the RPL link, and all the nodes perform a Forwarding Database (FDB) flush which allows traffic to quickly return.

When a Signal Fail (SF) has been detected, the node detecting the fault will block that port for its protected VLANs, do an FDB flush for its protected VLANs, and will send out an R-APS message with a request to switch due to signal failure. It will send this R-APS(SF) message out both of its ring ports. The R-APS is first sent as a burst of three R-APS messages, and then continues to send this message every 5 seconds until the Signal Fail (SF) condition abates. Like the RPL-Owner, it will also send the R-APS message with the node-id of itself and the BPR indicating which of its ring ports is being blocked. As the newly generated R-APS message is received by the other nodes, each node notices that the Node-id and BPR are different from what was previously received, causing it to perform an FDB flush. The R-APS message is finally received at the RPL-Owner and the RPL-Neighbor. The R-APS(SF) is also an indicator that there is a block somewhere else in the ring, and this allows the RPL-Owner and RPL-Neighbor to remove their blocks without concern for forming a loop.

Example: When a node on the link detects a fault, it immediately blocks the faulty node and reports the fault

message (R-APS (SF)) to all the other devices in the ring. After receiving the message, all other nodes refresh the FDB. The RPL owner port receives the fault message, and the recovery port is in the forwarding state. The ERPS ring enters the protection state



1.3.3 REVERTIVE AND NON-REVERTIVE OPERATIONS

G.8032 also provides for revertive operations. Once the failure clears and after a waiting time of typically 5 minutes, the ring switches back to its normal mode of operation. G.8032 also provides for a non-revertive operation, where once the failure abates, a protection switch back to the normal state does not occur. In this case, the links where the failure had occurred remain blocked and the RPL remains unblocked. A clear command, described below, is provided for you to control whether a revertive or non-revertive operation is allowed.

1. REVERTIVE

In ideal case, the link between the Root Node and the Root Neighbor is blocked. In case of Signal Failure or operator command like Forced Switch or Manual Switch occurs, the aforementioned link gets unblocked in order to steer the traffic. Upon recovery, the same link should get blocked to prevent the formation of loop. In the Revertive mode of operation, upon the recovery of the failed link, the Ring Protection Link gets blocked automatically.

2. NON-REVERTIVE

In Non-Revertive mode, upon the recovery of failed link or operator commands, the Ring Protection Link doesn't get blocked automatically. The failed link or the link upon which the operator command was issued remains in the blocked state, thereby preventing in loop formation. The advantage behind here is to avoid unnecessary toggling between states. This toggling may necessitate flushing of learnt MAC address on the ports.

NOTE: When revertive operations are used, the ring will not revert back immediately. Reversion does not start until the Wait-To-Restore timer has expired, which is 5 minutes by default.

1.3.4 FORCED SWITCH (FS) AND MANUAL SWITCH (MS)

Forced Switch (FS) is a command that can be issued to force a ring to switch. The command is issued at a given node and a given interface on the ring. This results in a block being applied at that interface and an unblock on the opposite interface, and an R-APS Forced Switch (FS) message to flow around the ring. This will result in the RPL becoming unblocked. Any other nodes that had a block previously will also unblock when they get this message. FDB flushes also occur along the way.

NOTE: Forced Switch (FS) commands can be issued at multiple locations along the ring. However, doing so may result in the ring becoming segmented.

The Manual Switch (MS) command is nearly identical to a Forced Switch (FS) command except that only one Manual Switch (MS) command can be issued on the ring. It also has a lower priority than a Forced Switch (FS) command when a node has many requests that it needs to process at the same time.

To undo this operation, use the clear command at the same node. This will cause the clearing node to unblock any block it had previously applied. It will also send a R-APS No Request (NR) message, which in turn will cause the RPL to become blocked again.

1.3.5 ERPS STATE

There are five states in the ERPS Protocol

1. IDLE STATE

This state represent there is no Signal Fail or any administrative command (Forced/Manual Switch) prevailing over the ring. The RPL (Ring Protection Link) is blocked (doesn't carry data traffic, but Tx/Rx the APS PDU's).

2. PROTECTION STATE

This state represents the Signal Fail condition in the Ring. Normally the RPL is unblocked to steer the traffic in the ring. When more than one Signal Fail occurs in the Ring, it results in segmenting the ring. Traffic flow is disturbed.

3. PENDING STATE

This state occurs when the Signal Fail condition is revoked by the issuer, and the RPL is not still blocked. Generally, the Root node after receiving the No Request Message (indication of No Signal Fail condition) waits till the Wait-To-Restore time to block the RPL. This is the condition where the Ring goes into Pending State. It also occurs during the waiting period in wait-to-block after revoking forced/manual switch.

4. FORCED SWITCH

This is management triggered state. When a administrator needs to make a port down which is participating in ring, this management entity will come into action. When a Forced Switch object is issued on the port, the port

goes down and the APS PDU gets propagated around the ring indicating the status. When the clear management object is set on the port, this Forced Switch is revoked.

Note: This has higher precedence to Signal Fail status. So, even when some node is facing Signal Fail, this will supersede it.

5. MANUAL SWITCH

Similar to Forced Switch, the Manual Switch is also management triggered. The difference is that, it has lower priority compared to Forced switch. When there is a Forced Switch or Signal Fail prevailing over the ring, this condition is rejected by the ERPS process. The clear management object will revoke the Manual Switch state.

1.3.6 TIMERS

There are four timers involved in the ERPS protocol. The last two timers are the delay timers and are employed only on the Root Node.

1. HOLD-OFF TIMER

After the expiry of the Hold-off timer, the problem in the physical layer is communicated to the ERPS Control Process. In example it defers the indication of Signal Fail on one of ring ports for a period of configured Hold-off time.

2. GUARD TIMER

This timer is used to prevent the outdated messages from interfering with the ERPS State machine of that ring. When the node clear's its Signal Fail condition, the guard timer is started. When the guard timer is running, it rejects all the APS PDU except the 'event' message. This timer is used to prevent any latent information which is arriving from the far end of the ring.

3. WAIT-TO-BLOCK TIMER

As mentioned earlier, the Wait-to-Block timer is employed at that Root Node. This timer is used when the ring recovers from the operator command (Forced Switch or Manual Switch). When the Wait-to-Block Timer expires the Ring Protection Link is blocked.

4. WAIT-TO-RESTORE TIMER

When the ring recovers the Signal Failure the Root Node starts the Wait-to-Restore Timers. Upon expiry the Ring Protection Link is blocked. If it is a revertive mode of operation, it is blocked at once. In case of non-revertive it is blocked when the operator command "clear" is given.

1.3.7 ERPS MESSAGES

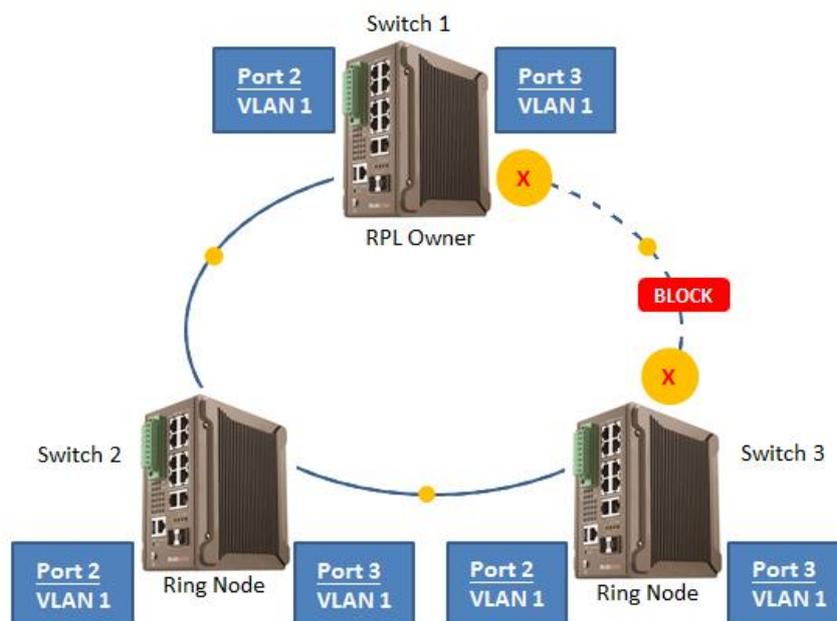
Different types of ERPS Messages are

1. **SIGNAL FAIL (SF)** - This message denotes failure of the Ring Link.
2. **NO REQUEST (NR)** - This indicates clearing of the failure in the Ring Link
3. **NO REQUEST ROOT BLOCKED (NR, RB)** - This is transmitted by the Root node, denoting that, the Ring Protection Link is blocked.
4. **FORCED SWITCH (FS)** - This message indicates that Forced Switch has occurred.
5. **MANUAL SWITCH (MS)** - This message indicates that Manual Switch has occurred.

2. HOW TO CONFIGURE ERPS

In this manual, we are using an example of a standard ring environment that consist of 3 switches. Through this section we will try to configure the ERPS using web management interface.

The Ring figure should be like below:



The topology above is the standard topology, the multi switch constitutes a single ERPS Ring, all of the switches are configured as an ERPS in VLAN 1, thereby constituting a single ring.

SWITCH ID	PORT	RPL TYPE	VLAN GROUP
Switch 1	Port 2	RPL Owner	VLAN 1
	Port 3		
Switch 2	Port 2	Ring node	VLAN 1
	Port 3		
Switch 3	Port 2	Ring Node	VLAN 1
	Port 3		

The scenario described as follow:

1. Set the proper static IP for each switch 1, 2 & 3. In this example, switch 1 is 192.168.10.2; switch 2 is 192.168.10.4 and switch 3 is 192.168.10.6.
2. And the basic rule for ERPS here in the Major Ring should have one RPL Owner. In this case the RPL Owner is Switch 1. And we set Switch 2 and Switch 3 as Ring Node.

3. Set all the revertive mode with Revertive.

4. Use default setting for the other configurations and submit the configuration for each node, then connect the Ethernet cable.

5. The first status : Normal Ring condition.

The Ring LED in switch 1 as the RPL Owner should Green Blinking. And for Switch 2 and 3 the Ring LED should Green On.

6. The second status : Ring Port Fail condition

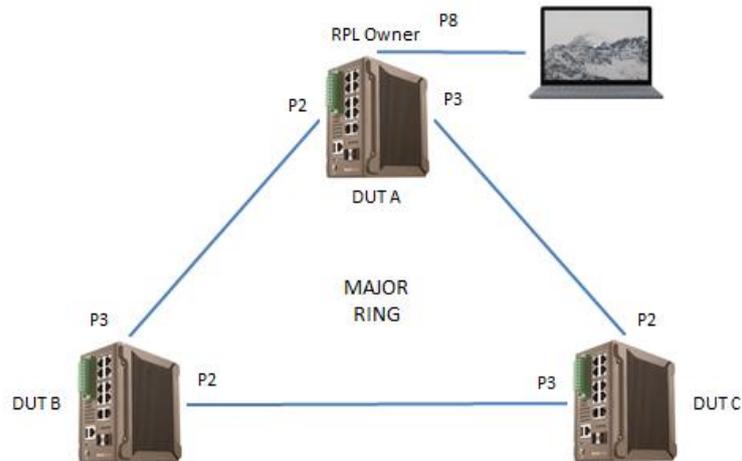
When user disconnect one cable in the Ring Environment, all of the Ring LED should be Amber Blinking. But the the package transmission still work normally.

Setup Step:

- Set ERPS Configuration on each switches.
- Connect PC to Switch 1 directly, don't connect to port 2 or 3.
- Log in on Switch 1 and click Redundancy > ERPS Settings > ERPS Setting

2.1 MAJOR RING CONFIGURATION

Major Ring is an Ethernet ring that controls a full physical ring and is connected on two ports. And major ring is a fully closed topology. The minimum number to compose a ring is two nodes. The example below is a four node ring. Each node connects to the ring via two ports, also called links. One of the links in the ring is designated as a Ring Protection Link (RPL). One end of the RPL link is designated as the Owner, and the other end of the link is designated as the Neighbor.



Below is the procedure to build a simple ERPS Ring environment. (all of the steps used Womaster Web Management Interface)

SWITCH 1

Go to Switch 1 Web Management then enter the Redundancy section and go to ERPS Setting page. In this page user can configure the ERPS function for Switch 1.

Add ERPS Instance.

Add the ERPS Instance ID and the VLAN Group. Choose Instance ID : 0 and Add VLAN 1 to the VLAN Group.

Click Add,

Instance ID	VLAN group
0	

Add

and the ERPS Instance Setting table will display the ID and the VLAN Group.

ERPS Instance Setting

Instance ID:

0

Add ERPS Ring.

The next step is Add ERPS Ring.

In this section, user need to add the Ring ID. Choose the default value and then click Add.

Add ERPS Ring

Ring ID:

ERPS Ring Setting

After user add Ring ID, a new line will directly create in ERPS Ring Setting table

ERPS Ring Setting

Ring ID	Version	Ring State	Node Role	Control Channel	Sub Ring without Virtual Channel	Virtual Channel of Sub Ring	Ring Port 0	Ring Port 1	RPL port	Revertive Mode	Instance	Manual Switch	Force Switch
<input type="checkbox"/> 0	v2	Enable	RPL Owner	1	False	1	2	3	1	Revertive	None	None	None

In this section, user need to set up the Ring for Switch 1.

Follow this step:

- The version just use the default setting v2.
- Set up the Node Role for RPL Owner for Switch 1.
- Set up the Ring Port 0 and Ring Port 1 adjust with the port that we will use for the ERPS (in this example we used port 2 & 3).
- Revertive Mode, choose Revertive (For more information, please refers to 1.3.3)
- Instance, choose none for the Instance ID
- Set None for Manual Switch and Force Switch.

ERPS Timer Setting

Ring ID	Guard Timer(ms)	WTR Timer(m)
0	100	5

For ERPS Timer, set the Guard Timer to 100 and Wait-to-Restore to 5. To have the quick Restore time.

SWITCH 2 & 3

After setting up the for Switch 1, user can start configure the ERPS function for Switch 2 & 3.

Add ERPS Instance.

Add the ERPS Instance ID and the VLAN Group. Choose Instance ID : 0 and Add VLAN 1 to the VLAN Group.

Click Add, and the ERPS Instance Setting table will display the ID and the VLAN Group.

Home > Redundancy > ERPS Setting

RSTP Settings ▾ MSTP Settings ▾ ERPS Settings ▾ Loop Protection

ERPS Setting

Add ERPS Instance

Instance ID	VLAN group
0	

ERPS Instance Setting

Instance ID	VLAN group
<input type="checkbox"/> 0	1

Add ERPS Ring.

The next step is Add ERPS Ring.

In this section, user need to add the Ring ID. Choose 1 and then click Add.

Add ERPS Ring

Ring ID	0
---------	---

ERPS Ring Setting

After user add Ring ID, a new line will directly create in ERPS Ring Setting table

Ring ID	Version	Ring State	Node Role	Control Channel	Sub Ring without Virtual Channel	Virtual Channel of Sub Ring	Ring Port 0	Ring Port 1	RPL port	Revertive Mode	Instance	Manual Switch	Force Switch
<input type="checkbox"/> 0	v2	Enable	Ring Node	1	False	1	2	3	1	Revertive	None	None	None

In this section, user need to set up the Ring for Switch 2 & 3.

Follow this step:

- Use the default version : v2.
- Set up the Node Role for Ring Node for Switch 2 & 3.
- Set up the Ring Port 0 and Ring Port 1 adjust with the port that we will use for the ERPS (in this example we used port 2 & 3).
- RPL port choose 1.
- Revertive Mode, choose Revertive (For more information, please refers to 1.3.3)
- Instance, choose none for the Instance ID.
- Set None for Manual Switch and Force Switch.

ERPS Timer Setting

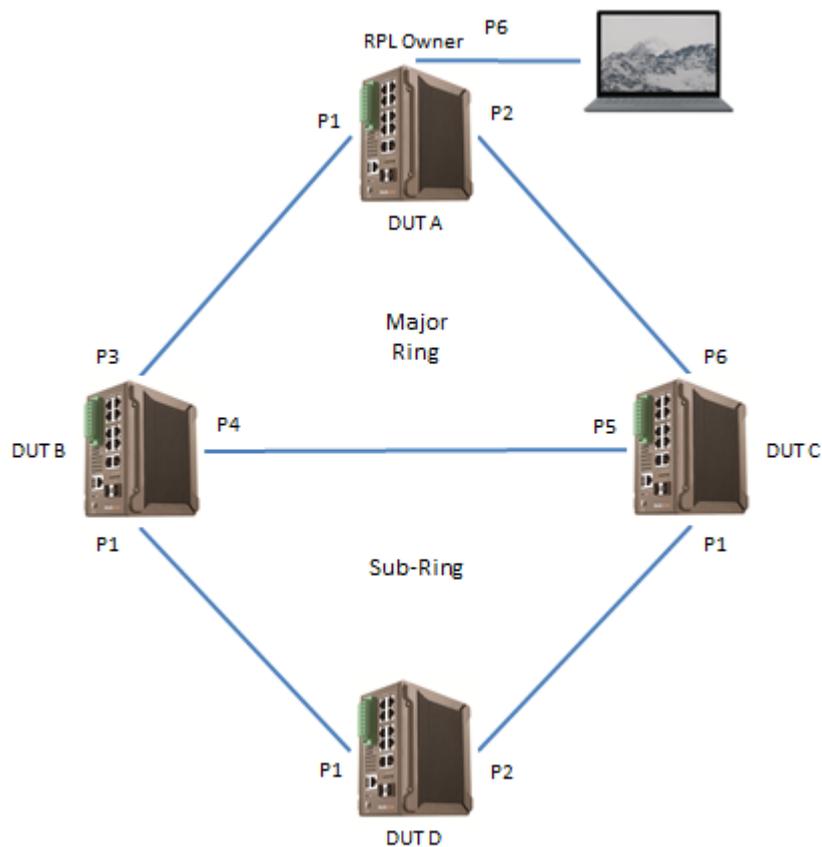
Ring ID	Guard Timer(ms)	WTR Timer(m)
1	100	1

For ERPS Timer, set the Guard Timer to 100 and Wait-to-Restore to 5 for the default setting.

After setting all of the ERPS configuration, now connect the Ethernet cable.

2.2 SUB-RING CONFIGURATION

Sub-Ring is an Ethernet ring that is connected and attached to a major ring, either directly, or via another sub-ring. By itself, the Sub-Ring does not constitute a closed ring and this allows for complex ring topologies to be built. One of the differences between a sub-ring and a major ring is that the raps-channel control VLAN is not blocked anywhere along the path of the sub-ring, even though the protected data VLANs may be blocked. When configuring all the nodes in the sub-ring, the user should make sure those nodes are configured to operate as sub-rings. One exception is that when a sub-ring also uses a virtual channel, the raps-channel VLAN blocking behavior is the same as that of a major ring.



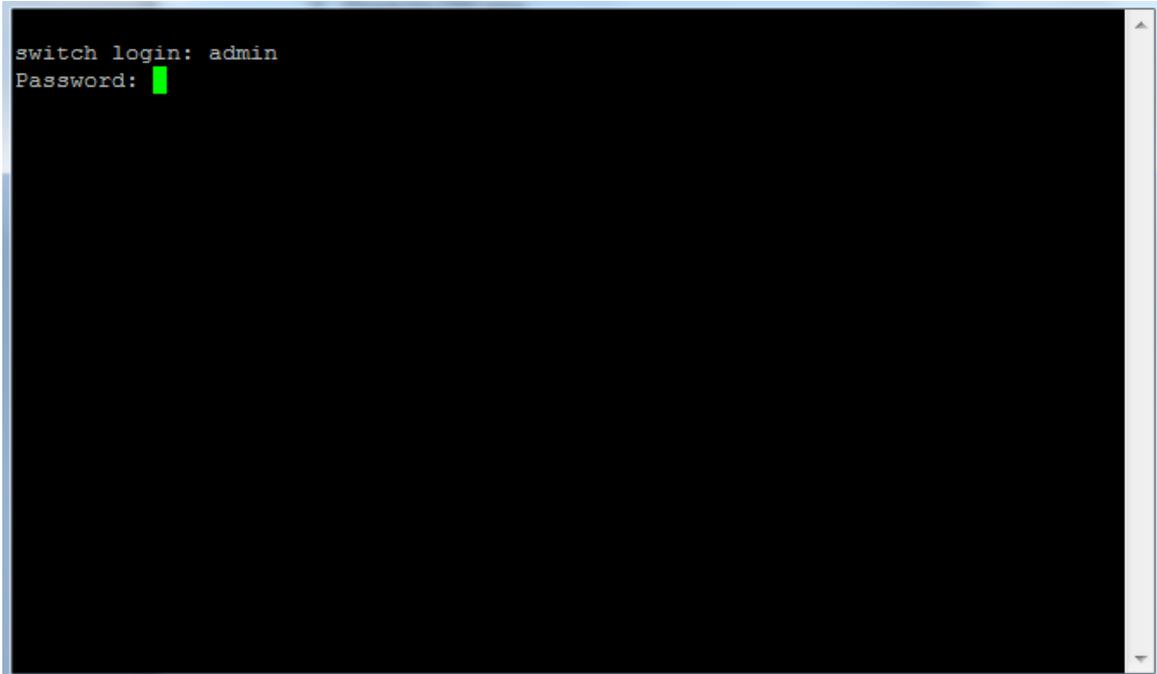
Below is the configuration step for the Sub-ring, before configure the sub-ring user must configure the Major Ring first. So this step will divide into two parts, for the Major Ring and Sub-ring.

The step below used CLI Command.

Attach RJ-45 to RS-232 DB-9 console cable to PC's COM port; connect RJ45 connector to the Console port of the **WoMaster Managed Switch.**

1. Go to Start -> Program -> Accessories -> Communication -> Hyper Terminal
2. Give a name to the new console connection.

3. Choose the COM name
4. Select correct serial settings. The serial settings of **Womaster Managed switches** are as below:
Baud Rate: 115200 / Parity: None / Data Bit: 8 / Stop Bit: 1
5. After connected, switch login screen can be seen.

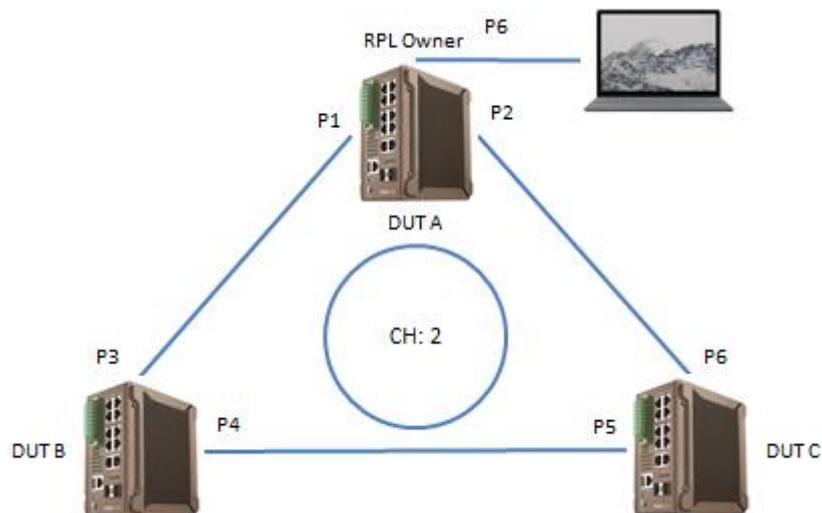
A terminal window with a black background and white text. The text reads "switch login: admin" on the first line and "Password: " on the second line, followed by a green cursor. The terminal has a blue border and a vertical scrollbar on the right side.

```
switch login: admin
Password: █
```

6. Login the switch. The default username: **admin**; password: **admin**.

2.2.1 MAJOR RING

In this section we will set the Major Ring first, following the figure below.



Follow the settings below:

CLI Command for Switch 1 [DUT1]

```
switch(config)# interface fe1
switch(config-if)# switchport trunk allowed vlan add 2
switch(config-if)# exit
switch(config)# interface fe2
switch(config-if)# switchport trunk allowed vlan add 2
switch(config-if)# exit erps 11
switch(config)# erps 11
Ring 11 created
switch(config-erps)# ring-port fe1 fe2
Ring ports are changing to fe1 fe2
switch(config-erps)# node-role rpl-owner
Set ERPS node role success.
switch(config-erps)# time wtr-timer 1
Assign WTR timer success.
switch(config-erps)# control-channel 2
Assign control channel success.
switch(config-erps)# version 2
Set ERPS version success.
switch(config-erps)# enable
Enable ERPS success.
switch(config-erps)# exit
switch(config)#
```

Ring LED Status: Green Blinking (RPL Owner)

CLI Command for Switch 2 [DUT2]

```
switch(config)# interface fe3
switch(config-if)# switchport trunk allowed vlan add 2
switch(config-if)# exit
switch(config)# interface fe4
switch(config-if)# switchport trunk allowed vlan add 2
switch(config-if)# exit
switch(config)# erps 12
Ring 12 created
switch(config-erps)# ring-port fe3 fe4
Ring ports are changing to fe3 fe4
switch(config-erps)# control-channel 2
Assign control channel success.
switch(config-erps)# version 2
Set ERPS version success.
switch(config-erps)# enable
Enable ERPS success.
switch(config-erps)# exit
switch(config)#
```

Ring LED Status: Green On

CLI Command for Switch 3 [DUT3]

```
switch(config)# interface fe5
switch(config-if)# switchport trunk allowed vlan add 2
switch(config-if)# exit
switch(config)# interface fe6
switch(config-if)# switchport trunk allowed vlan add 2
switch(config-if)# exit
switch(config)# erps 13
Ring 13 created
switch(config-erps)# ring-port fe5 fe6
Ring ports are changing to fe5 fe6
switch(config-erps)# control-channel 2
Assign control channel success.
switch(config-erps)# version 2
Set ERPS version success.
switch(config-erps)# enable
Enable ERPS success.
switch(config-erps)# exit
switch(config)#
```

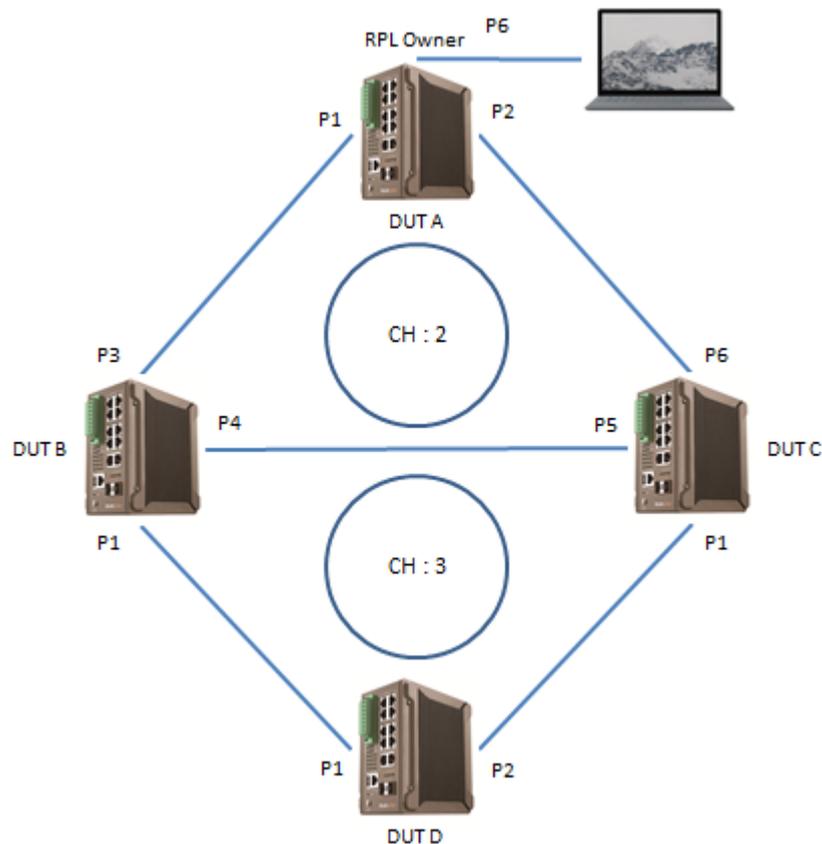
Ring LED Status: Green On

ERPS Ring Status Test

Condition	ERPS Status
Disconnect P4->P5	all of the DUT status is protection
Reconnect P4->P5	all of the DUT status is pending and WTR is running and after WTR timer expired, the status becomes idle.

2.2.2 SUB-RING WITH VIRTUAL CHANNEL

After finished configure the Major Ring, start configure the Sub-Ring.



Follow the configuration below:

CLI Command for Switch 1 [DUT1]

```
switch(config)# interface fe1
switch(config-if)# switchport trunk allowed vlan add 4
switch(config-if)# exit
switch(config)# interface fe2
switch(config-if)# switchport trunk allowed vlan add 4
switch(config-if)# exit
```

Ring LED Status: Green Blinking (RPL Owner)

CLI Command for Switch 2 [DUT2]

```
switch(config)# erps 22
Ring 22 created
switch(config-erps)# ring-port fe1 none
```

```
Ring ports are changing to fe1 none
switch(config-erps)# control-channel 3
Assign control channel success.
switch(config-erps)# virtual-channel 4
Assign virtual channel success.
switch(config-erps)# enable
Enable ERPS success.
switch(config-erps)# exit
switch(config)# interface fe1
switch(config-if)# switchport trunk allowed vlan add 3
switch(config-if)# switchport trunk allowed vlan add 4
switch(config-if)# exit
switch(config)# interface fe3
switch(config-if)# switchport trunk allowed vlan add 4
switch(config-if)# exit
switch(config)# interface fe4
switch(config-if)# switchport trunk allowed vlan add 4
```

Ring LED Status: Green On

CLI Command for Switch 3 [DUT3]

```
switch(config)# erps 23
Ring 23 created
switch(config-erps)# ring-port fe1 none
Ring ports are changing to fe1 none
switch(config-erps)# control-channel 3
Assign control channel success.
switch(config-erps)# virtual-channel 4
Assign virtual channel success.
switch(config-erps)# enable
Enable ERPS success.
switch(config-erps)# exit
switch(config)# interface fe1
switch(config-if)# switchport trunk allowed vlan add 3
switch(config-if)# switchport trunk allowed vlan add 4
switch(config-if)# exit
switch(config)# interface fe5
switch(config-if)# switchport trunk allowed vlan add 4
switch(config-if)# exit
switch(config)# interface fe6
switch(config-if)# switchport trunk allowed vlan add 4
switch(config-if)# exit
switch(config)#
```

Ring LED Status: Green On

CLI Command for Switch 4 [DUT4]

```
switch(config)# erps 24
Ring 24 created
switch(config-erps)# ring-port fe1 fe2
Ring ports are changing to fe1 fe2
switch(config-erps)# node-role rpl-owner
Set ERPS node role success.
switch(config-erps)# timer wtr-timer 1
Assign WTR timer success.
switch(config-erps)# control-channel 3
Assign control channel success.
switch(config-erps)# virtual-channel 4
Assign virtual channel success.
switch(config-erps)# enable
Enable ERPS success.
switch(config-erps)# exit
switch(config)# interface fe1
switch(config-if)# switchport trunk allowed vlan add 3
switch(config-if)# exit
switch(config)# interface fe2
switch(config-if)# switchport trunk allowed vlan add 3
switch(config-if)# exit
```

Ring LED Status: Green Blinking (RPL Owner)

ERPS Ring Status Test

Condition	ERPS Status
Disconnect P1<->P3	DUT A : ring LED Amber blinking r11 / status protection / fe1 blocking / fe2 forwarding
	DUT B : ring LED Amber blinking r12 / status protection / fe3 blocking / fe4 forwarding r22 / status idle / fe1 forwarding
	DUT C : ring LED Amber on r13 / status protection / fe5 forwarding / fe6 forwarding r23 / status idle / fe1 forwarding
	DUT D : ring LED Green blinking r24 / status idle / fe1 forwarding / fe2 blocking
Disconnect P1<->P1	DUT A : ring LED Amber blinking r11 / status protection / fe1 forwarding / fe2 forwarding
	DUT B : ring LED Amber blinking r12 / status protection / fe3 forwarding / fe4 blocking r22 / status protection / fe1 blocking
	DUT C : ring LED Amber on r13 / status protection / fe5 blocking / fe6 forwarding r23 / status protection / fe1 forwarding
	DUT D : ring LED Amber blinking

	r24 / status protection / fe1 blocking / fe2 blocking
Reconnect P1<->P3	DUT A start WTR timer and the r11/r12/r13 into pending status. The r22/r23/r24 keep protection status
	DUT A : ring LED Green blinking
	r11 / status idle / fe1 blocking / fe2 forwarding
	DUT B : ring LED Amber blinking
	r12 / status idle / fe3 blocking / fe4 forwarding
DUT A WTR timer expired	r22 / status protection / fe1 blocking
	DUT C : ring LED Green on ??
	r13 / status idle / fe5 forwarding / fe6 forwarding
	r23 / status protection / fe1 forwarding
	DUT D : ring LED Amber blinking
	r24 / status protection / fe1 blocking / fe2 blocking
Reconnect P1<->P1	DUT D start WTR timer and the r22/r23/r24 into pending status. The r11/r12/r13 keep idle status
	DUT A : ring LED Green blinking
	r11 / Status idle / fe1 blocking / fe2 forwarding
	DUT B : ring LED Green on
	r12 / status idle / fe3 blocking / fe4 forwarding
DUT D WTR timer expired	r22 / status idle / fe1 forwarding
	DUT C : ring LED Green blinking
	r13 / status idle / fe5 forwarding / fe6 forwarding
	r23 / status idle / fe1 forwarding
	DUT D : ring LED Green blinking
	r24 / status idle / fe1 forwarding / fe2 blocking

3. ERPS RING LED STATUS

The LED status will tell user about the condition from the ERPS Ring. There are two Ring LED Status, one on the device itself and the other one is in the Web Management Panel.

Ring LED on the switch:

LED	DESCRIPTION
Green On	Not Owner/Normal
Green Blinking	RPL Owner/Normal
Amber On	Abnormal
Amber Blinking	Ring Port Fail (Local SF)
Off	Ring is disabled

Ring LED on the Web Management Panel:

LED	DESCRIPTION
Green On	Not Owner/Normal
Amber On	Abnormal
Off	Ring is disabled