iConverter® ITU-G.8032
Ethernet Ring Protection Switch

iConverter
Managed Fiber Media Converter
Product Family

Document Number: 002-A0003
Revision A
October 2017

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Table of Contents

ITU-T G.8032 Ethernet Ring Protection Switching

Introduction

The predominate ring transport network used by Service Providers is Synchronous Digital Hierarchy (SDH)/ Synchronous Optical Networking (SONET). SDH/SONET networks with sub-50msec service protection provides Service Providers a reliable transport network. With the introduction of Carrier Ethernet by the Metro Ethernet Forum (MEF), ring topologies using Ethernet networks were required to meet the protection objectives used by SDH/SONET. Traditionally, Ethernet networks used Spanning Tree Protocol to ensure a loop-free topology. However, convergence times were high and in-determinate.

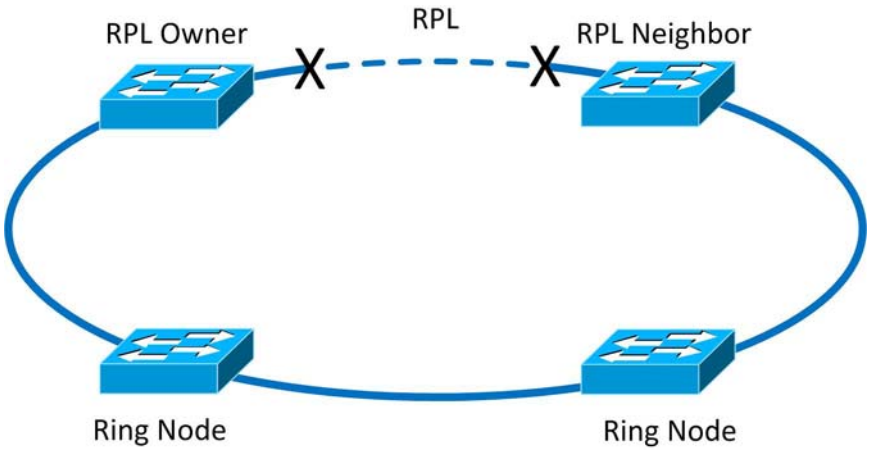
The ITU-T defined a method to achieve the same protection used by SDH/SONET transport networks for Ethernet ring topologies. ITU-T G.8032 Ethernet Ring Protection Switching (ERPS) achieved this protection by having each ERPS node in the ring send messages to its neighboring node to determine its availability. When a fiber loss occurs, the failure is immediately determined and an alternate path is established. When used in conjunction with IEEE 802.1ag Connectivity Fault Management (CFM), a 3.3 millisecond messaging interval can be configured to ensure rapid service restoration.

Utilizing Ethernet in a ring topology provides efficient network connectivity, supporting multiple services while allowing flexible deployment scenarios for Access, Metro and Core network applications.

Overview

ERPS uses G.8032 Ethernet Ring Protection (ERP) protocol to provide protection for Ethernet traffic on the ring. This protection ensures that no Ethernet data loops are created by the ring. Loops are prevented by blocking traffic on a predetermined link, called the Ring Protection Link (RPL).

Nodes on a ERPS ring are configured as ether the RPL Owner, RPL Neighbor or Ring Node. The RPL Owner controls the state of the ring. It is responsible to block and unblock traffic on the RPL based on the state of the nodes on the ring.



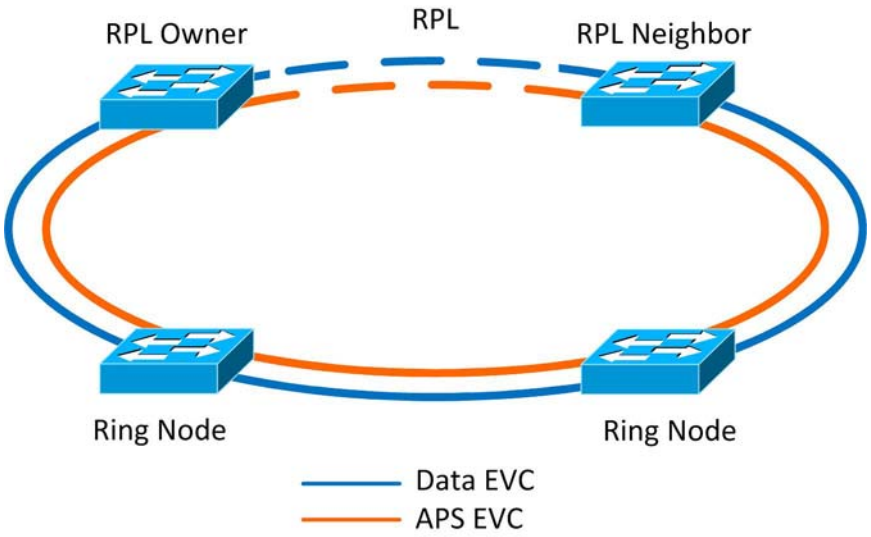
Nodes on the ring communicate using control messages called Ring Automatic Protection Switching (R-APS) messages. These messages are used to determine the state of the RPL (unblocked or blocked). Under normal conditions (no failures), the RPL Owner will block traffic on one end of the RPL. The RPL Neighbor will block the traffic at the other end of the RPL. R-APS messages do not travel across the RPL.

When a failure on the ring occurs, the nodes adjacent to the failed link will generate a R-APS Signal Failure (R-APS SF) message and will block the port facing the failure. Once the RPL Owner receives the messages, the RPL Owner will unblock the RPL and send R-APS messages causing the RPL Neighbor to unblock the RPL, allowing the RPL to be used for data traffic.

When a failed link is restored, the nodes adjacent to the restored link sends R-APS and R-APS No Request (R-APS NR) messages. Upon receipt of the messages, the Ring Owner will block the RPL and sends R-APS NR and R-APS messages. These messages cause all other nodes in the ring to unblock all blocked ports.

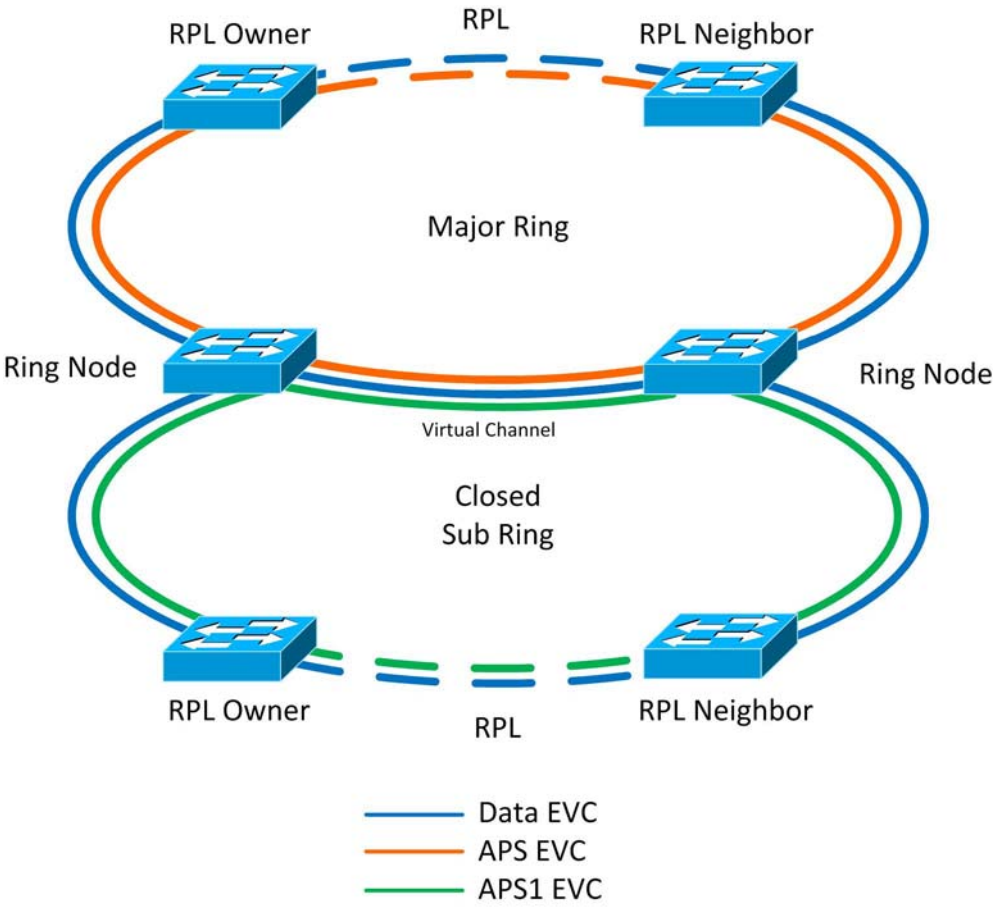
ERPS Ring Topology

An ERPS ring consists of at least two nodes to a maximum of 16 nodes. Each node is connected to the ring via two ports called Ring Ports. One node will be configured as the RPL Owner and an adjacent node will be configured as the RPL Neighbor. The link between the Owner and Neighbor is the RPL. The nodes on the ERPS ring is referred to as the Main Ring or Major Ring. At a minimum, two channels (or EVCs) are defined on the ring. One is the control channel or R-APS messaging channel and one is the protected channel or data traffic.

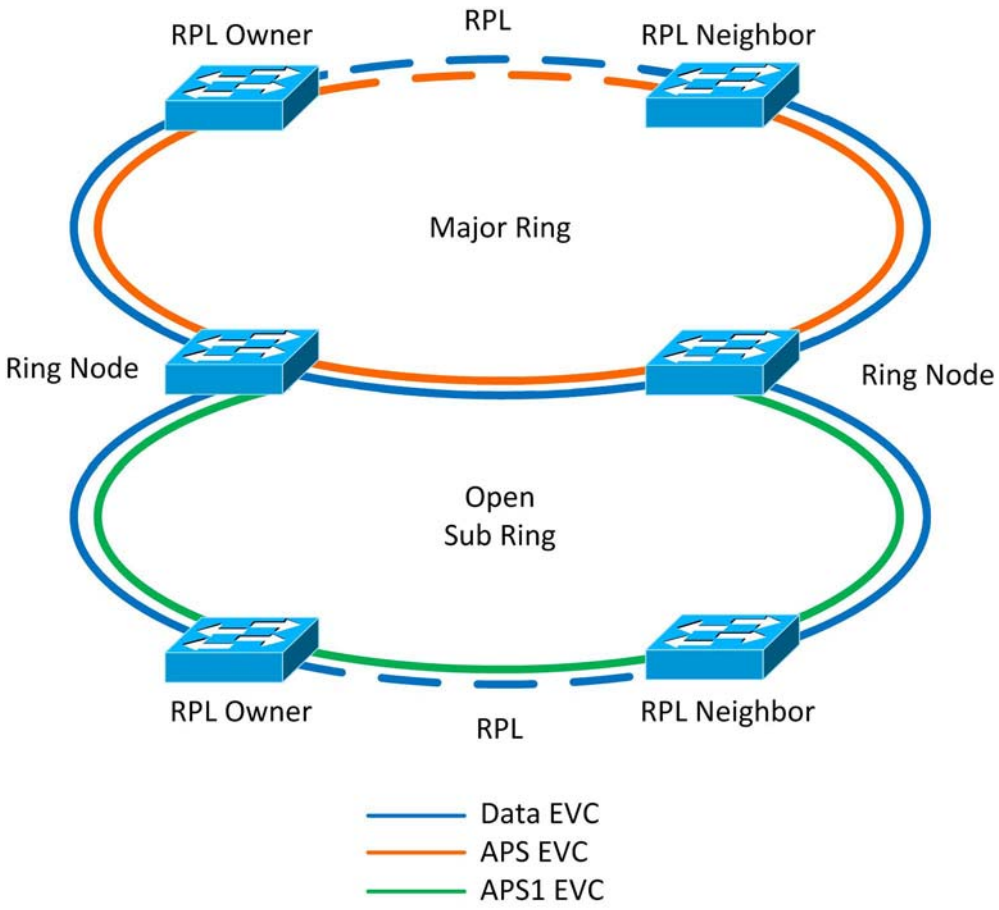


ERPS supports sub ring topologies. A Sub Ring is connected to the Major Ring at interconnecting nodes. A Sub Ring has the option to be configured as a closed or open ring.

A closed Sub Ring will share a path on the Major Ring called a virtual channel. The virtual channel allows the R-APS messages of the Sub Ring to form a complete ring. Because the virtual channel forms a complete ring through the interconnecting Ring Nodes on the Major Ring, failure times are improved.



An open Sub Ring terminates the R-APS channel at each of the interconnecting Ring Node and does not use any resources on the Major Ring. The Sub Ring R-APS messages only travel over the RPL and associated links of the Sub Ring.



G.8032 ERPS Administrative and Timers

Administrative Functions

G.8032 ERPS supports basic administrative commands to manually control the operation of the ERPS ring. ERPS supports:

Force: Forces a ring port to be blocked. Ring status will indicate a forced switch condition. The force command can be issued even when a fault condition exists on the ring. A clear command must be issued to revert the ring port back to its previous state.

Manual: Manually blocks a ring port. Ring status will indicate a manual switch condition. The manual command will not block a port when a fault condition exists on the ring. A clear command must be issued to revert the ring port back to its previous state.

Clear: Clear to normal operation (clears force, manual and wait-to-restore state).

Timers

G.8032 ERPS specifies different timers for the avoidance race conditions and switching operations. All timers are disabled by default.

Hold-off Time: The hold-off time delays the switching mechanism, so upstream devices will have a chance to resolve the problem. The default time is set to zero. Use the ***-holdoff*** command to configure the hold-off time.

Wait to Restore: Wait to Restore (WTR) timer indicates the wait time after the condition causing a switchover has cleared before reverting back to the working link (only when Revert to working has been configured). Use the ***-wtrtime*** command to configure the WTR timer. The default time is 5 minutes.

Wait to Block: The Wait to Block (WTB) timer is used when clearing a forced switch and manual switch operation. Use the ***-wtbtime*** command to configure the WTB timer. The default time is 5 seconds.

Guard Time: The guard timer is used to prevent Ethernet ring nodes from acting upon outdated R-APS messages and prevents the possibility of forming a closed loop. Use the ***-guardtime*** command to configure the guard time. The default time is 500 milliseconds.

G.8032 ERPS Commands

Basic configuration commands are listed below. These commands relate to Omnitron Systems Network Interface Devices that support G.8032 ERPS functionality. If an option is not defined in the ERPS command string, the device will use the default values.

ERPS Instance:	To name the ERPS instance, use the ***-pn*** command.
Ring ID:	Each ERPS Ring must have a unique Ring ID. Use the ***-ringid*** command. The default value is 1.
Ring Type:	Define the ring type by using the ***-rtyp*** command: closed or open. Open indicates the sub ring is terminated at the interconnect nodes on the Major Ring. Closed indicates all nodes are connected forming a closed physical ring. The default value is closed.
Reversion Type:	Revert to Primary restores normal traffic to the primary link after the condition causing a switch has cleared or a clearing command has been issued. No Revert to Primary causes normal traffic to remain on the protection link even after the condition causing the switch has been cleared. Use the ***-ena rev*** command to configure for revert to primary. The default is disabled.
APS EVC:	R-APS messages are transmitted on the APS EVC. The APS EVC can be configured using on a Port based, EVC based or 802.1ag based ERPS instance. Use the ***-aev*** command to define the EVC name for the R-APS channel.
APS Domain Level:	Configure the domain level for the R-APS channel by using ***-amd*** command. The default domain level is 0.
APS Frame Priority:	Configure the R-APS channel pbit priority by using the ***-pri*** command. The default priority level is 0.
Protected EVC:	Configure the protected EVCs associated with the ERPS instance using the ***-e*** command. If an EVC is not defined, the ERPS instance is port-based.
Ring Port 0:	Configure the parameters associated with ring port 0 by using the ***-rp0*** command. The command defines the specific port number, 802.1ag MEP associated attributes (md/ma/mep) and port function (RPL Owner, RPL Neighbor, RPL Next Neighbor or Ring Node). The format for Port or EVC based configurations is: *-rp0 portnum:ro|rn|nn* The format for 802.1ag MEP based configurations is: *-rp0 portnum;md,ma,mep:ro|rn|nn*

Ring Port 1: Configure the parameters associated with ring port 1 by using the ***-rp1*** command. The command defines the specific port number and 802.1ag MEP associated attributes (md/ma/mep).

The format for Port or EVC based configurations is:
-rp1 portnum

The format for 802.1ag MEP based configurations is:
-rp portnum;md,ma,mep

How to Configure G.8032 ERPS

Configure Ethernet Virtual Circuits (EVC)

It is recommended, at a minimum, to configure a management, data and automatic protection switching EVC. Assign each EVC to the desired ports and S-Tag.

```
evc -a -e data     -p 1,2,3        -v 1001
evc -a -e mgt      -p 1,2,3,mgt    -v 2000
evc -a -e aps      -p 1,2          -v 2001
```

The associations between the EVCs and ports define the path for each service on the device. The data and management C-Tags will be associated with the customer-facing (UNI) and network-facing (NNI) ports.

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 3   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

Configure ERPS Instance

Port-Based Example:

Port-based ERPS instance as the name implies provides protection to the port not individual EVCs.

1. A basic port-based instance requires an instance name (*-pn*), assignment of the ring ports (*-rp0 and -rp1*), the APS EVC (*-aev*), APS domain level (*-amd*), timer settings (*-wtrtime*) and APS priority (*-pri*).
2. The ERPS profile will need to be enabled along with the reversion type (*rev*) and timers (*wtr*). Only the Ring Owner requires the wait to restore timer. All nodes require the same reversion type.
3. The ERPS protocol will need to be globally enabled on the module (*-ena erps*).

```
1.  erps -a -pn majoraps -rpo 1:ro -rp1 2 -aev aps -amd 3 -wtrtime 1 -pri 7
2.  erps -ena profile majoraps rev,wtr
3.  erps -ena erps
```

EVC-Base Example:

EVC-based ERPS instance provides protection to individual EVCs.

1. A basic EVC-based instance requires an instance name (*-pn*), protected EVC (*-e*), assignment of the ring ports (*-rp0 and -rp1*), the APS EVC (*-aev*), APS domain level (*-amd*), timer settings (*-wtrtime*) and APS priority (*-pri*).
2. Any additional protected EVCs will need to be assigned to the ERPS instance.
3. The ERPS profile will need to be enabled along with the reversion type (*rev*) and timers (*wtr*). Only the Ring Owner requires the wait to restore timer. All nodes require the same reversion type.
4. The ERPS protocol will need to be globally enabled on the module (*-ena erps*).

```
1.  erps -a -pn majoraps -e data -rp0 1:ro -rp1 2 -aev aps -amd 3 -pri 7
    -wtrtime 1
2.  erps -a -pn majoraps -e mgt
3.  erps -ena profile majoraps rev,wtr
4.  erps -ena erps
```

802.1ag MEP-Based Example:

802.1g MEP-based ERPS instance uses Connectivity Check Messages (CCMs) as the fault detection mechanism to provide up to 50msec protection switchover.

IEEE 802.1ag parameters must be configured first before the ERPS instance is defined.

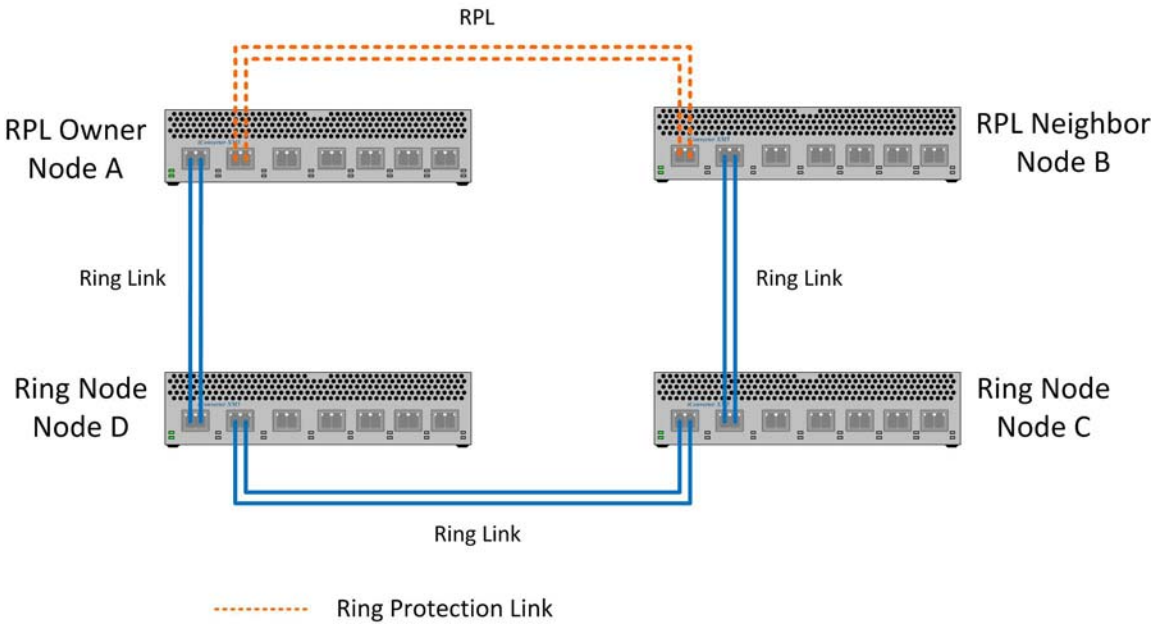
1. A basic MEP-based with MEP instance requires an instance name (*-pn*), protected EVC (*-e*), assignment of the ring ports (*-rp0 and -rp1*), the APS EVC (*-aev*), APS domain level (*-amd*), timer settings (*-wtrtime*) and APS priority (*-pri*). The ring port will be associated with the 802.1ag parameters (*-rp0 portnum;md,ma,mep*) and ring owner or neighbor.
2. Any additional protected EVCs will need to be assigned to the ERPS instance.
3. The ERPS profile will need to be enabled along with the reversion type (*rev*) and timers (*wtr*). Only the Ring Owner requires the wait to restore timer. All nodes require the same reversion type.
4. The ERPS protocol will need to be globally enabled on the module (*-ena erps*).

```
1.  erps -a -pn majoraps -e data -rp0 1;6,MA06,11:ro -rp1 2;6,MA06,12
    -aev aps -amd 3 -wtrtime 1 -pri 7
2.  erps -a -pn majoraps -e mgt
3.  erps -ena profile majoraps rev,wtr
4.  erps -ena erps
```

ITU-T G.8032 ERPS Major Ring Example

EVC-Based Configuration

In this example, four iConverter XM5 Network Interface Devices are configured for an EVC-based ERPS Major Ring. Node A is configured as the RPL Owner and Node B is configured as the RPL Neighbor. Both nodes are responsible for blocking the transmission and reception of traffic over the RPL.



The following scripts configure an EVC-based ERPS 4 Node Major Ring

Node A – RPL Owner

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data  -p 1,2,7     -v 1001
evc -a -e mgt   -p 1,2,7,mgt -v 2000
evc -a -e aps   -p 1,2       -v 2001
```

```
interface -a -p 1 -t nni
interface -a -p 2 -t nni
interface -a -p 7 -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
erps -a -pn majoraps -e data -rp0 2:ro -rp1 1 -aev aps -amd 3 -wtrtime 1 -pri 7
erps -a -pn majoraps -e mgt
erps -ena profile majoraps rev,wtr
erps -ena erps
```

Port 2 is configured as the RPL (Ring Protection Link) with the module designated as the Ring Owner (*-rp0 2:ro*).

Node B – RPL Neighbor

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data -p 1,2,7     -v 1001
evc -a -e mgt  -p 1,2,7,mgt -v 2000
evc -a -e aps  -p 1,2       -v 2001
```

```
interface -a -p 1 -t nni
interface -a -p 2 -t nni
interface -a -p 7 -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
erps -a -pn majoraps -e data -rp0 1:rn -rp1 2 -aev aps -amd 3 -pri 7
erps -a -pn majoraps -e mgt
erps -ena profile majoraps rev
erps -ena erps
```

Port 1 is configured as the RPL with the module designated as the Ring Neighbor (*-rp0 1:rn*).

Node C

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data -p 1,2,7     -v 1001
evc -a -e mgt  -p 1,2,7,mgt -v 2000
evc -a -e aps  -p 1,2       -v 2001
```

```
interface -a -p 1 -t nni
interface -a -p 2 -t nni
interface -a -p 7 -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
erps -a -pn majoraps -e data -rp0 1 -rp1 2 -aev aps -amd 3 -pri 7
erps -a -pn majoraps -e mgt
erps -ena profile majoraps rev
erps -ena erps
```

Node D

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data -p 1,2,7     -v 1001
evc -a -e mgt  -p 1,2,7,mgt -v 2000
evc -a -e aps  -p 1,2       -v 2001
```

```
interface -a -p 1 -t nni
interface -a -p 2 -t nni
interface -a -p 7 -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
erps -a -pn majoraps -e data -rp0 1 -rp1 2 -aev aps -amd 3 -pri 7
erps -a -pn majoraps -e mgt
erps -ena profile majoraps rev
erps -ena erps
```

To display the status of the ERPS instance for Node A, use the *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 3

Last protection switch: Jan 1, 2000 12:11AM (sysUpTime: 74200)
Total number of protection switches: 4

Ring Status: idle
Ring port 0: port 2; status=Up, blocked
 APS VID "aps"; RPL owner
Ring port 1: port 1; status=Up, forward
 APS VID "aps"
```

A corelation between the ERPS status and commands is provided below:

`ERPS Protocol: enabled`	*-ena erps*
`Profile name: majoraps`	*-pn majoraps*
`Ring Id: 1`	default value (*-ringid*)
`Ring Status: Operational`	
`Protection Instance: Enabled`	*-ena profile majoraps*
`Revertive: Enabled`	*-ena profile majoraps rev*
`Ring type: Closed`	default value (*-rtyp*)
`APS frame transmission rate: 5 sec;`	default value (*-txrate*)
`number of APS frames at switch: 3`	default value (*-txsend*)
`Wait-to-Restore timer: enabled, 1 min`	*-wtrtime*
`Wait-to-Block timer: disabled, 5 sec`	default value (*-wtbtime*)
`Hold-Off timer: disabled, 0 ms`	default value (*-holdoff*)
`Guard timer: disabled, 500 ms`	default value (*-guardtime*)
`Protected traffic channel: EVC "data", "mgt"`	*-a -pn majoraps -e mgt* *-a -pn majoraps -e data*

```
R-APS Frame Priority: 7,                    -pri 7
domain level 3                              -amd 3


Ring status: idle
Ring port 0: port 2; status=Up, blocked
 APS VID "aps"; RPL owner
Ring port 1: port 1; status=Up, forward
 APS VID "aps"
```

The ring status indicates the state of the ERPS ring. There are five states:

Pending:	Ring is initizing or restoring to normal operation
Idle:	Ring is operational
Protection:	A fault condition exists on the ring
Manual Switch:	A manual switch command has been issued (*-mo manual*)
Forced Switch:	A forced switch command has been issued (*-mo force*)

RPL Owner is blocking the RPL (Port 2) and forwarding all traffic across the Port 1 (Ring Link).

To display the status of the ERPS instance for Node B, use the *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 3

Last protection switch: Jan 1, 2000 06:25AM (sysUpTime: 2312988)
Total number of protection switches: 9

Ring status: idle
Ring port 0: port 1; status=Up, blocked
 APS VID "aps"; RPL neighbor
Ring port 1: port 2; status=Up, forward
 APS VID "aps"
```

RPL Neighbor is blocking the RPL (Port 1) and forwarding all traffic across Port 2 (Ring Link).

To display the status of the ERPS instance for Node C, use the *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 3

Last protection switch: Jan 3, 2000 01:09AM (sysUpTime: 17695552)
Total number of protection switches: 8

Ring status: idle
Ring port 0: port 1; status=Up, forward
 APS VID "aps"
Ring port 1: port 2; status=Up, forward
 APS VID "aps"
```

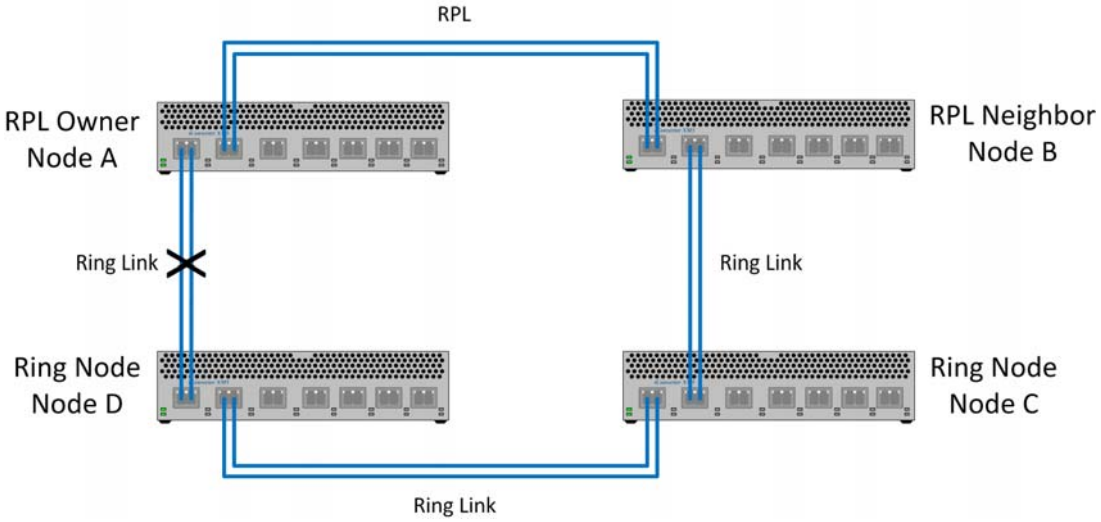
Ring Node (Node C) is forwarding traffic out both ports.

To display the status of the ERPS instance for Node D, use the *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 3

Last protection switch: Jan 2, 2000 08:15PM (sysUpTime: 15933755)
Total number of protection switches: 6

Ring status: idle
Ring port 0: port 1; status=Up, forward
 APS VID "aps"
Ring port 1: port 2; status=Up, forward
 APS VID "aps"
```

Ring Node (Node D) is forwarding traffic out both ports.

Breaking the Ring Link between Node A and D will cause the RPL Owner to unblock the Ring Protection Link.



To display the status of the ERPS instance for Node A, use the *erps -s* command.

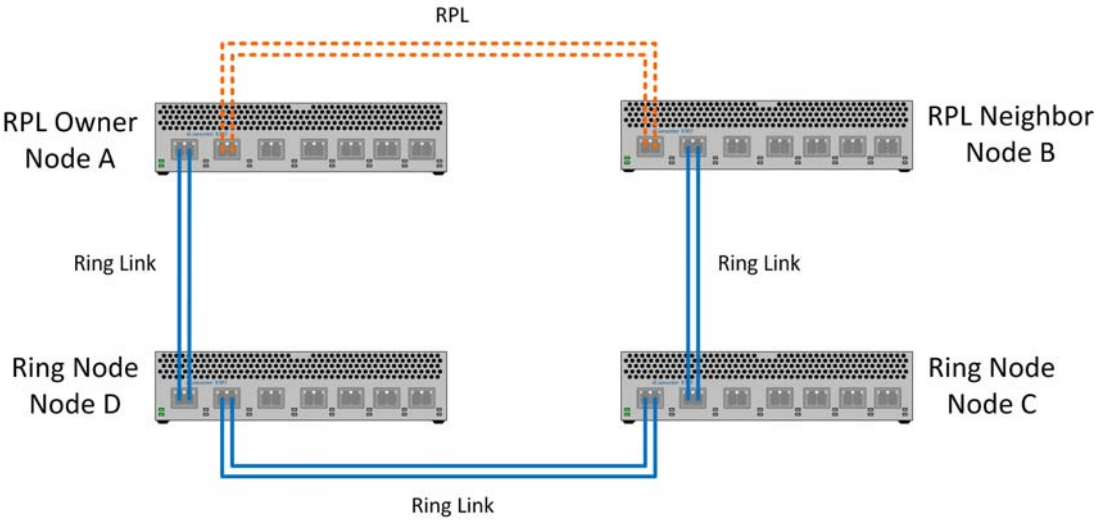
```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 3

Last protection switch: Jan 1, 2000 07:33AM (sysUpTime: 2723093)
Total number of protection switches: 5

Ring status: protection
Ring port 0: port 2; status=Up, forward
 APS VID "aps"; RPL owner
Ring port 1: port 1; status=Down, blocked
 APS VID "aps"
```

The Ring status has changed from “idle” to “protection”, indicating a fault on the ring.

RPL Owner unblocks the (Port 2) due to the failure on Port 1. Port 1 status is down and blocked. All traffic is forwarded across Port 2.

All nodes in the ERPS Ring will indicate a Ring status of “protection” and will forward all traffic out all ports that have a status=Up.

Re-establishing the link between Node A and Node D, returns the ring back to its original configuration.



To display the status of the ERPS instance for Node A, use the *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 3

Last protection switch: Jan 1, 2000 07:50AM (sysUpTime: 2822246)
Total number of protection switches: 7

Ring status: idle
Ring port 0: port 2; status=Up, blocked
 APS VID "aps"; RPL owner
Ring port 1: port 1; status=Up, forward
 APS VID "aps"
```

The Ring status returned to “idle”, indicating the ring is operational.

RPL Owner is blocking the RPL (Port 2) and forwarding all traffic across Port 1 (Ring Link). All nodes will indicate a Ring status of “idle”.

IEEE 802.1ag Service OAM

IEEE 802.1ag Service OAM Connectivity Fault Management provides the capability to detect, verify, and isolate connectivity failures. 802.1ag Service OAM uses frames called OAM Protocol Data Units (PDU) to send/receive messages to detect loss of service connectivity and perform loopback/linktrace tests to verify and isolate faults along an end-to-end Ethernet connection.

To create an end-to-end Ethernet service path, 802.1ag uses the concepts of Maintenance Domains, Maintenance Associations and Maintenance End Points.

Maintenance Domain (MD)

A Maintenance Domain defines a boundary of responsibility. There can be multiple carriers providing an Ethernet service to a customer. Each carrier defines their boundary of responsibility, or domain level. These levels make it easy to delineate the responsibilities and make it easy to manage and detect faults along an Ethernet service.

Maintenance Association (MA)

A Maintenance Association is a group of maintenance points that defines the physical end-to-end service path. When a Maintenance Association is created, it is associated with a specific Maintenance Domain, VLAN ID (EVC) and port number.

Maintenance Points

Any port on a network may be configured as a maintenance point. A maintenance point is classified as a Maintenance Association End Point (MEP) or Maintenance Domain Intermediate Point (MIP).

Maintenance End Point (MEP)

Maintenance End Points reside at the edge of a Maintenance Domain and generate and terminate OAM PDU messages. When a Maintenance End Point is created, it is associated with a specific Maintenance Domain, Maintenance Association, VLAN ID (EVC) and port number.

A Maintenance End Point can be defined as UP or DOWN MEP. An UP MEP monitors the forwarding path internal to the node, while a DOWN MEP only monitors the forwarding path external to the node. An UP MEP is configured on the ingress port, while the DOWN MEP is configured on the egress port. It is recommended that all ports on the ring be configured as DOWN MEPs.

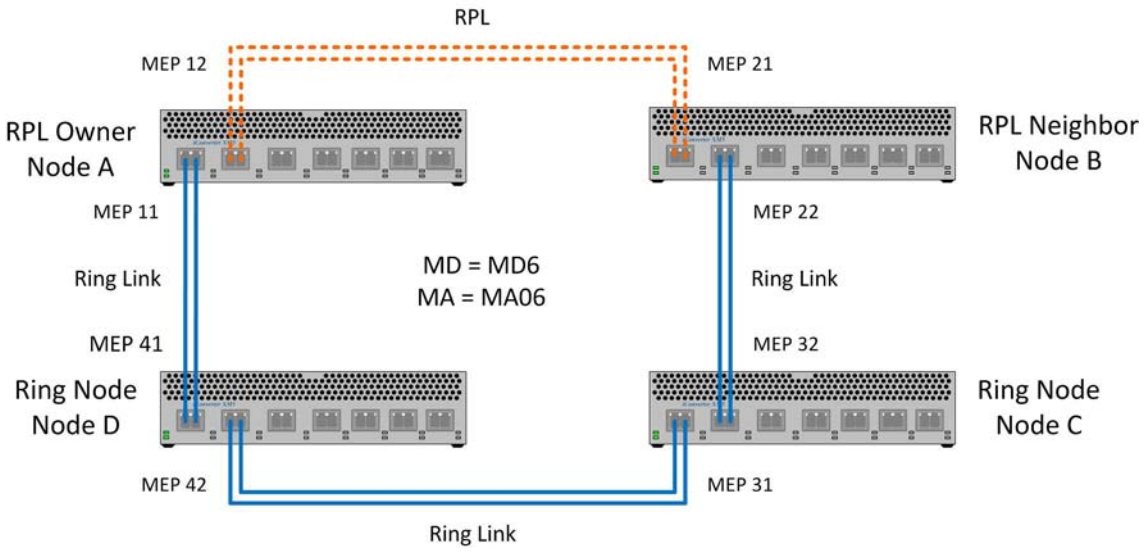
Maintenance Intermediate Point (MIP)

Maintenance Intermediate Points are internal to the domain. Maintenance Intermediate Points will forward OAM PDUs. Maintenance Intermediate Points will forward and respond to loopback and linktrace OAM PDUs. If the loopback message is intended for the Maintenance Intermediate Point, the loopback message will not be forwarded.

802.1ag MEP-Based Configuration

In this example, four iConverter XM5 Network Interface Devices are configured for an 802.1ag MEP-based ERPS Major Ring. Node A is configured as the RPL Owner and Node B is configured as the RPL Neighbor. Both nodes are responsible for blocking the transmission and reception of traffic over the RPL.

IEEE 802.1ag Connectivity Fault Management is configured on each node. 3.3msec Connectivity Check Messages (CCMs) are used to ensure a 50msec protection switchover. Each node will be configured on Maintenance Domain MD6 and Maintenance Association MA06. Maintenance End Points will be configured on each of the ring ports on the nodes.



IEEE 802.1ag parameters must be configured on each node in the ring.

Configure a Maintenance Domain (*md -a*) named MD6 (*-n*) on domain level 6 (*-l*):

```
md   -a -n MD6 -l 6
```

Configure a Maintenance Association (*ma -a*) associated with Maintenance Domain MD6 (*-l*) named MA06 (*-o*) on EVC aps (*-e*) with CCM set to 3.3msec (*-i*):

```
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
```

Configure a Maintenance End Point (*mep -a*) associated with Maintenance Association MA06 (*-o*) on EVC aps (*-e*) for Port 1 (*-p*) with a MEP identifier (*-m*) of 11 and configured as a Down MEP (*-dn*):

```
mep  -a -l 6 -o MA06 -e aps -p 1 -m 11 -dn
```

Configure a Maintenance End Point (*mep -a*) assoicated with Maintenance Association MA06 (*-o*) on EVC aps (*-e*) for Port 2 (*-p*) with a MEP identifier (*-m*) of 12 and configured as a Down MEP (*-dn*):

```
mep  -a -l 6 -o MA06 -e aps -p 2 -m 12 -dn
```

Configure a Remote Maintenance End Point (r*mep -a*) assoicated with Maintenance Association MA06 (*-o*) with a RMEP identifier (*-m*) of 21 and a local MEP identifier (*-lmep*) of 11.

```
rmep -a -l 6 -o MA06 -m 21 -lmep 11
```

Configure a Remote Maintenance End Point (r*mep -a*) assoicated with Maintenance Association MA06 (*-o*) with a RMEP identifier (*-m*) of 41 and a local MEP identifier (*-lmep*) of 12.

```
rmep -a -l 6 -o MA06 -m 41 -lmep 12
```

The following scripts configure a 802.1ag MEP-base ERPS 4 Node Major Ring.

Node A – RPL Owner

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data  -p 1,2,7     -v 1001
evc -a -e mgt   -p 1,2,7,mgt -v 2000
evc -a -e aps   -p 1,2       -v 2001
```

```
interface -a -p 1 -t nni
interface -a -p 2 -t nni
interface -a -p 7 -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 11 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 12 -dn
rmep -a -l 6 -o MA06 -m 42 -lmep 11
rmep -a -l 6 -o MA06 -m 21 -lmep 12
```

```
erps -a -pn majoraps -e data -rp0 2;6,MA06,12:ro -rp1 1;6,MA06,11 -aev aps -pri 7 -wtrtime 1
erps -a -pn majoraps -e mgt
erps -ena profile majoraps rev,wtr
erps -ena erps
```

Port 2 is configured as the RPL with the module designated as the Ring Owner (*-rp0 1:ro*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node B – RPL Neighbor

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data  -p 1,2,7     -v 1001
evc -a -e mgt   -p 1,2,7,mgt -v 2000
evc -a -e aps   -p 1,2       -v 2001
```

```
interface -a -p 1 -t nni
interface -a -p 2 -t nni
interface -a -p 7 -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 21 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 22 -dn
rmep -a -l 6 -o MA06 -m 12 -lmep 21
rmep -a -l 6 -o MA06 -m 32 -lmep 22
```

```
erps -a -pn majoraps -e data -rp0 1;6,MA06,21:rn -rp1 2;6,MA06,22 -aev aps -pri 7
erps -a -pn majoraps -e mgt
erps -ena profile majoraps rev
erps -ena erps
```

Port 1 is configured as the RPL with the module designated as the Ring Neighbor (*-rp0 1:rn*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node C

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data  -p 1,2,7     -v 1001
evc -a -e mgt   -p 1,2,7,mgt -v 2000
evc -a -e aps   -p 1,2       -v 2001
```

```
interface -a -p 1 -t nni
interface -a -p 2 -t nni
interface -a -p 7 -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 31 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 32 -dn
rmep -a -l 6 -o MA06 -m 42 -lmep 31
rmep -a -l 6 -o MA06 -m 22 -lmep 32
```

```
erps -a -pn majoraps -e data -rp0 1;6,MA06,31 -rp1 2;6,MA06,32 -aev aps -pri 7
erps -a -pn majoraps -e mgt
erps -ena profile majoraps rev
erps -ena erps
```

Node D

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data  -p 1,2,7     -v 1001
evc -a -e mgt   -p 1,2,7,mgt -v 2000
evc -a -e aps   -p 1,2       -v 2001
```

```
interface -a -p 1 -t nni
interface -a -p 2 -t nni
interface -a -p 7 -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 41 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 42 -dn
rmep -a -l 6 -o MA06 -m 11 -lmep 41
rmep -a -l 6 -o MA06 -m 31 -lmep 42
```

```
erps -a -pn majoraps -e data -rp0 1;6,MA06,41 -rp1 2;6,MA06,42 -aev aps -pri 7
erps -a -pn majoraps -e mgt
erps -ena profile majoraps rev
erps -ena erps
```

To display the status of the ERPS instance for Node A, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
11    41     2   2   6   1    2001  OK/None    00-06-87-02-14-a1 MD6/MA06
12    21     2   2   6   2    2001  OK/None    00-06-87-01-e5-c1 MD6/MA06


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 12:55AM (sysUpTime: 339000)
Total number of protection switches: 10

Ring Status: idle
Ring port 0: port 2; status=Up, blocked
  MD level 6; MA name MA06; MEP ID 12; APS VID "aps"; RPL owner
Ring port 1: port 1; status=Up, forward
  MD level 6; MA name MA06; MEP ID 11; APS VID "aps"
```

MEPs exchange Continuity Check Messages (CCMs) with remotely connected end points. The *rmep -s* command provides a status of the CCM connection between the local and remote MEP.

The Status column indicates the condition of the connection.

Idle: A momentary state during reset.

Start: No valid Continuity Check Messages (CCM) has yet been received.

Failed: Timer has expired since a valid CCM was received.

OK: Valid CCM have been received.

The Defect column indicates the status of RDI from the remote MEP.

RDI: Remote end point is sending a Remote Defect Indication (RDI). This indicates a failure condition at the far end (possibly a link down condition on the port).

None: No RDI is received.

The RMEP status indicates a good connection between the local and remote MEPs.

RPL Owner is blocking the RPL (Port 2) and forwarding all traffic across Port 1 (Ring Link).

To display the status of the ERPS instance for Node B, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
21    12     2   2   6   1    2001  OK/None    00-06-87-02-13-f2 MD6/MA06
22    32     2   2   6   2    2001  OK/None    00-06-87-01-ff-22 MD6/MA06


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 12:54AM (sysUpTime: 331900)
Total number of protection switches: 8

Ring Status: idle
Ring port 0: port 1; status=Up, blocked
  MD level 6; MA name MA06; MEP ID 21; APS VID "aps"; RPL neighbor
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 22; APS VID "aps"
```

The RMEP status indicates a good connection between the local and remote MEPs.

RPL Neighbor is blocking the RPL (Port 1) and forwarding all traffic across Port 2 (Ring Link).

To display the status of the ERPS instance for Node C, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
31    42     2   2   6   1    2001  OK/None    00-06-87-02-14-a2 MD6/MA06
32    22     2   2   6   2    2001  OK/None    00-06-87-01-e5-c2 MD6/MA06


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 12:51AM (sysUpTime: 314500)
Total number of protection switches: 5

Ring Status: idle
Ring port 0: port 1; status=Up, forward
  MD level 6; MA name MA06; MEP ID 31; APS VID "aps"
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 32; APS VID "aps"
```

The RMEP status indicates a good connection between the local and remote MEPs.

Ring Node (Node C) is forwarding traffic out both ports.

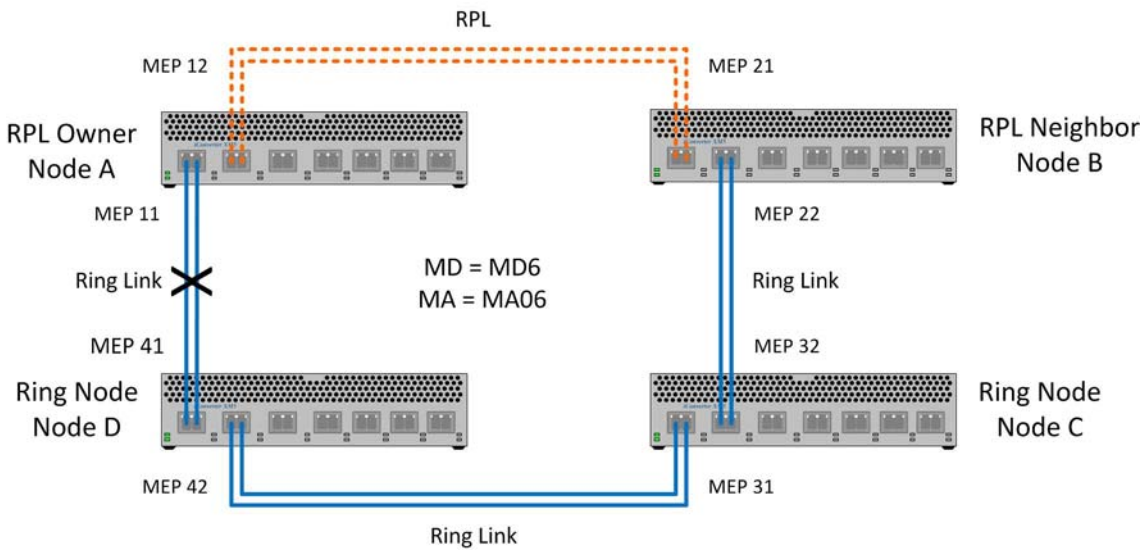
To display the status of the ERPS instance for Node D, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
41    11     2   2   6   1    2001  OK/None    00-06-87-02-13-f1 MD6/MA06
42    31     2   2   6   2    2001  OK/None    00-06-87-01-ff-21 MD6/MA06


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 12:55AM (sysUpTime: 337100)
Total number of protection switches: 11

Ring Status: idle
Ring port 0: port 1; status=Up, forward
  MD level 6; MA name MA06; MEP ID 41; APS VID "aps"
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 42; APS VID "aps"
```

The RMEP status indicates a good connection between the local and remote MEPs.

Ring Node (Node D) is forwarding traffic out both ports.

Breaking the Ring Link between Node A and D will cause the RPL Owner to unblock the Ring Protection Link.



To display the status of the ERPS instance for Node A, use the *rmep -s* and *erps -s* command.

```
rmep -s
Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
11    41     2   2   6   1    2001  Fail/None  00-06-87-02-14-a1 MD6/MA06
12    21     2   2   6   2    2001  OK/None    00-06-87-01-e5-c1 MD6/MA06
```

The Maintenance End Point between Node A and Node D indicates a failed status condition.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 01:10AM (sysUpTime: 426900)
Total number of protection switches: 12

Ring Status: protection
Ring port 0: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 12; APS VID "aps"; RPL owner
Ring port 1: port 1; status=Down, blocked
  MD level 6; MA name MA06; MEP ID 11; APS VID "aps"
```

The Ring status has changed from “idle” to “protection”, indicating a fault on the ring.

RPL Owner unblocks the RPL (Port 2) due to the failure on Port 1. Port 1 status is down and blocked. All traffic is forwarded across Port 1.

All nodes will indicate a Ring status of “protection” and will forward all traffic out all ports that have a status=Up.

ITU-T G.8032 ERPS Major and Sub Ring Example

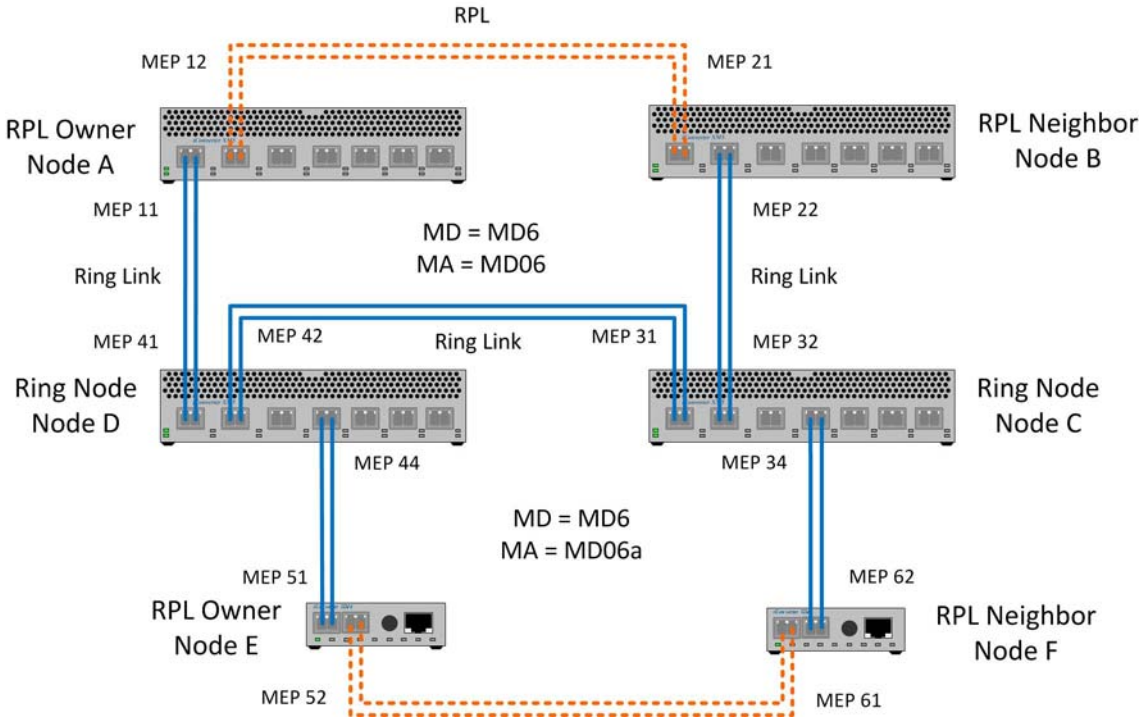
802.1ag MEP-Based Configuration

Closed Sub Ring with Virtual Channel

In this example, four iConverter XM5 Network Interface Devices are configured for an 802.1ag MEP-based with 802.1ag ERPS Major Ring and two iConverter GM4 Network Interface Devices are configured for an 802.1ag MEP-based ERPS Closed Sub Ring.

Node A is configured as the RPL Owner and Node B is configured as the RPL Neighbor of the Major Ring. Node E is configured as the RPL Owner and Node F is configured as the RPL Neighbor of the Sub Ring. The Owner and Neighbor is responsible for blocking the transmission and reception of traffic over the RPL. A virtual channel is configured on the Major Ring to close the Sub Ring.

IEEE 802.1ag Connectivity Fault Management is configured on each node. 3.3msec Connectivity Check Messages (CCMs) are used to ensure a 50msec protection switchover.



The following scripts configure an 8021ag MEP-base ERPS 4 Node Major Ring and a 2 Node Closed Sub Ring.

Node A – RPL Owner

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,7       -v 1001
evc -a -e mgt    -p 1,2,7,mgt   -v 2000
evc -a -e aps    -p 1,2         -v 2001
evc -a -e aps1   -p 1,2         -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 7   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 11 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 12 -dn
rmep -a -l 6 -o MA06 -m 41 -lmep 11
rmep -a -l 6 -o MA06 -m 21 -lmep 12
```

```
erps -ena erps
erps -a -pn majoraps -e data -rp0 2;6,MA06,12:ro -rp1 1;6,MA06,11 -aev aps -wtrtime 1 -pri 7
erps -a -pn majoraps -e mgt
erps -a -pn majoraps -e aps1
erps -ena profile majoraps rev,wtr
```

Port 2 is configured as the RPL with the module designated as the Ring Owner (*-rp0 2:ro*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node B – RPL Neighbor

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,7       -v 1001
evc -a -e mgt    -p 1,2,7,mgt   -v 2000
evc -a -e aps    -p 1,2         -v 2001
evc -a -e aps1   -p 1,2         -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 7   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 21 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 22 -dn
rmep -a -l 6 -o MA06 -m 12 -lmep 21
rmep -a -l 6 -o MA06 -m 32 -lmep 22
```

```
erps -ena erps
erps -a -pn majoraps -e data -rp0 1;6,MA06,21:rn -rp1 2;6,MA06,22 -aev aps -pri 7
erps -a -pn majoraps -e mgt
erps -a -pn majoraps -e aps1
erps -ena profile majoraps rev
```

Port 1 is configured as the RPL with the module designated as the Ring Neighbor (*-rp0 1:rn*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node C

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,4,7       -v 1001
evc -a -e mgt    -p 1,2,4,7,mgt   -v 2000
evc -a -e aps    -p 1,2           -v 2001
evc -a -e aps1   -p 1,2,4         -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 4   -t nni
interface -a -p 7   -t uni -e mgt:* -e data:100
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 31 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 32 -dn
rmep -a -l 6 -o MA06 -m 42 -lmep 31
rmep -a -l 6 -o MA06 -m 22 -lmep 32
##
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 4 -m 34 -dn
rmep -a -l 6 -o MA06a -m 62 -lmep 34
```

```
erps -ena erps
erps -a -pn majoraps -e data -rp0 1;6,MA06,31 -rp1 2;6,MA06,32 -aev aps -pri 7
erps -a -pn majoraps -e mgt
erps -a -pn majoraps -e aps1
erps -ena profile majoraps rev
##
erps -a -pn subaps -e data -rp0 4;6,MA06a,34 -rp1 vp -vdo majoraps -aev aps1 -rtyp closed -
pri 7
erps -a -pn subaps -e mgt
erps -ena profile subaps rev
```

Node C and D are interconnect node for the Sub Ring.

The interconnect nodes must support IEEE 802.1ag parameters for the Sub Ring and a virtual channel on the Major Ring.

A new Maintenance Association called MA06a is configured (*ma -a -o MA06a*) on the existing Maintenance Domain (MD6). The Maintenance Association is on the aps1 EVC with 3.3msec CCMs (-*i*). A Maintenance End Point is configured on Port 4 (-*p*) with a MEP identifier (-*m*) of 34 and configured as a Down MEP (-*dn*). The Maintenance End Point is associated (-*lmep*) with a Remote End Point identifier (-*m*) of 62.

```
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 4 -m 34 -dn
rmep -a -l 6 -o MA06a -m 62 -lmep 34
```

The Sub Ring ERPS command configure a virtual channel on the Major Ring using the *-rp1 vp -vdo majoraps* command and indicates the ring is closed (*-rtyp*) by the virtual channel.

```
erps -a -pn subaps -e data -rp0 4;6,MA06a,34 -rp1 vp -vdo majoraps -aev aps1 -rtyp closed
-pri 7
```

Node D

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,4,7       -v 1001
evc -a -e mgt    -p 1,2,4,7,mgt   -v 2000
evc -a -e aps    -p 1,2           -v 2001
evc -a -e aps1   -p 1,2,4         -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 4   -t nni
interface -a -p 7   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 41 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 42 -dn
rmep -a -l 6 -o MA06 -m 11 -lmep 41
rmep -a -l 6 -o MA06 -m 31 -lmep 42
##
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 4 -m 44 -dn
rmep -a -l 6 -o MA06a -m 51 -lmep 44
```

```
erps -ena erps
erps -a -pn majoraps -e data -rp0 1;6,MA06,41 -rp1 2;6,MA06,42 -aev aps -pri 7
erps -a -pn majoraps -e mgt
erps -a -pn majoraps -e aps1
erps -ena profile majoraps rev
##
erps -a -pn subaps -e data -rp0 4;6,MA06a,44 -rp1 vp -vdo majoraps -aev aps1 -rtyp closed -
pri 7
erps -a -pn subaps -e mgt
erps -ena profile subaps rev
```

Node E - RPL Owner

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,3         -v 1001
evc -a -e mgt    -p 1,2,3,mgt     -v 2000
evc -a -e aps    -p 1,2           -v 2001
evc -a -e aps1   -p 1,2           -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 3   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 1 -m 51 -dn
mep  -a -l 6 -o MA06a -e aps1 -p 2 -m 52 -dn
rmep -a -l 6 -o MA06a -m 44 -lmep 51
rmep -a -l 6 -o MA06a -m 61 -lmep 52
```

```
erps -ena erps
erps -a -pn subaps -e data -rp0 2;6,MA06a,52:ro -rp1 1;6,MA06a,51 -aev aps1 -pri 7
-wtrtime 1
erps -a -pn subaps -e mgt
erps -ena profile subaps rev,wtr
```

Port 2 is configured as the RPL of the Sub Ring with the module designated as the Ring Owner (*-rp0 2:ro*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node F – RPL Neighbor

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,3         -v 1001
evc -a -e mgt    -p 1,2,3,mgt     -v 2000
evc -a -e aps    -p 1,2           -v 2001
evc -a -e aps1   -p 1,2           -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 3   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 1 -m 61 -dn
mep  -a -l 6 -o MA06a -e aps1 -p 2 -m 62 -dn
rmep -a -l 6 -o MA06a -m 52 -lmep 61
rmep -a -l 6 -o MA06a -m 34 -lmep 62
```

```
erps -ena erps
erps -a -pn subaps -e data -rp0 1;6,MA06a,61:rn -rp1 2;6,MA06a,62 -aev aps1 -pri 7
erps -a -pn subaps -e mgt
erps -ena profile subaps rev
```

Port 1 is configured as the RPL of the Sub Ring with the module designated as the Ring Neighbor (*-rp0 1:rn*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

To display the status of the ERPS instance for Node A, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
11    41     3   3   6   1    2001  OK/None    00-06-87-02-14-a1 MD6/MA06
12    21     3   3   6   2    2001  OK/None    00-06-87-01-e5-c1 MD6/MA06


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt", "aps1"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 12:09AM (sysUpTime: 57100)
Total number of protection switches: 16

Ring Status: idle
Ring port 0: port 2; status=Up, blocked
  MD level 6; MA name MA06; MEP ID 12; APS VID "aps"; RPL owner
Ring port 1: port 1; status=Up, forward
  MD level 6; MA name MA06; MEP ID 11; APS VID "aps"
```

The RMEP status indicates a good connection between the local and remote MEPs.

RPL Owner is blocking the RPL (Port 2) and forwarding all traffic across Port 1 (Ring Link).

To display the status of the ERPS instance for Node B, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
21    12     3   3   6   1    2001  OK/None    00-06-87-02-13-f2 MD6/MA06
22    32     3   3   6   2    2001  OK/None    00-06-87-02-13-d2 MD6/MA06


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt", "aps1"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 12:08AM (sysUpTime: 57800)
Total number of protection switches: 4

Ring Status: idle
Ring port 0: port 1; status=Up, blocked
  MD level 6; MA name MA06; MEP ID 21; APS VID "aps"; RPL neighbor
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 22; APS VID "aps"
```

The RMEP status indicates a good connection between the local and remote MEPs.

RPL Neighbor is blocking the RPL (Port 1) and forwarding all traffic across Port 2 (Ring Link).

To display the status of the ERPS instance for Node C, use the *rmep -s* and *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 12:00AM (sysUpTime: 4500)
Total number of protection switches: 13

Ring Status: idle
Ring port 0: port 1; status=Up, forward
  MD level 6; MA name MA06; MEP ID 31; APS VID "aps"
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 32; APS VID "aps"

------ Ethernet Ring Protection Switching Instance #2 -----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: n/a (sysUpTime: 0)
Total number of protection switches: 0

Ring Status: idle
Ring port 0: port 4; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 34; APS VID "aps1"
Ring port 1: virtual port: virtual domain "majoraps"
```

Node C is an interconnect node for the Sub Ring and has two ERPS instances configured.

On both rings, Node C is forwarding traffic out all ports.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
31    42     5   9   6   1    2001  OK/None    00-06-87-02-14-a2 MD6/MA06
32    22     5   9   6   2    2001  OK/None    00-06-87-01-e5-c2 MD6/MA06
34    62     5   10  6   4    2002  OK/None    00-06-87-01-74-ee MD6/MA06a
```

Node C has Maintenance End Points associated for both ERPS instances. The RMEP status indicates a good connection between the local and remote MEPs.

To display the status of the ERPS instance for Node D, use the *rmep -s* and *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 12:08AM (sysUpTime: 50500)
Total number of protection switches: 5

Ring Status: idle
Ring port 0: port 1; status=Up, forward
  MD level 6; MA name MA06; MEP ID 41; APS VID "aps"
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 42; APS VID "aps"

------ Ethernet Ring Protection Switching Instance #2 ----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: n/a (sysUpTime: 0)
Total number of protection switches: 0

Ring Status: idle
Ring port 0: port 4; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 44; APS VID "aps1"
Ring port 1: virtual port: virtual domain "majoraps"
```

Node D is an interconnect node for the Sub Ring and has two ERPS instances configured.

On both rings, Node D is forwarding traffic out all ports.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
41    11     4   5   6   1    2001  OK/None    00-06-87-02-13-f1 MD6/MA06
42    31     4   5   6   2    2001  OK/None    00-06-87-02-13-d1 MD6/MA06
44    51     4   6   6   4    2002  OK/None    00-06-87-01-af-79 MD6/MA06a
```

Node D has Maintenance End Points associated with both ERPS instances. The RMEP status indicates a good connection between the local and remote MEPs.

To display the status of the ERPS instance for Node E, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
51    44     1   1   6   1    2002  OK/None    00-06-87-02-14-a4 MD6/MA06a
52    61     1   1   6   2    2002  OK/None    00-06-87-01-74-e9 MD6/MA06a


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 02:07AM (sysUpTime: 763155)
Total number of protection switches: 13

Ring status: idle
Ring port 0: port 2; status=Up, blocked
  MD level 6; MA name MA06a; MEP ID 52; APS VID "aps1"; RPL owner
Ring port 1: port 1; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 51; APS VID "aps1"
```

The RMEP status indicates a good connection between the local and remote MEPs.

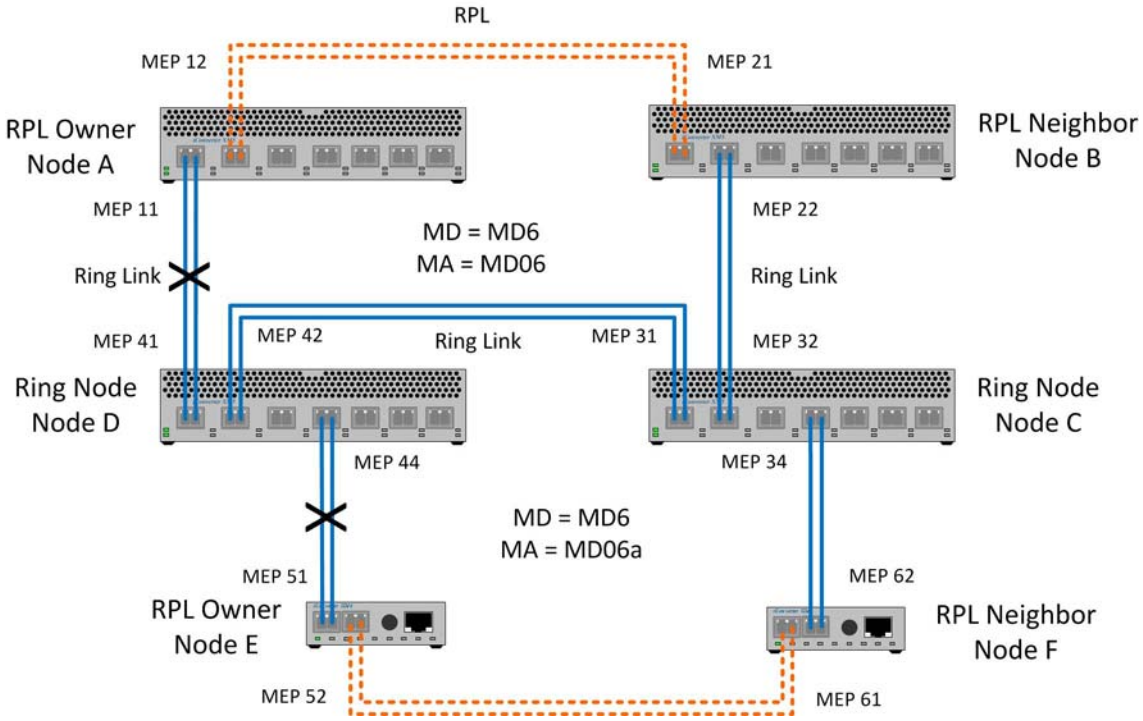
RPL Owner is blocking the RPL (Port 2) and forwarding all traffic across Port 1 (Ring Link).

To display the status of the EPRS instance for Node F, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
61    52     3   3   6   1    2002  OK/None    00-06-87-01-af-7e MD6/MA06a
62    34     3   3   6   2    2002  OK/None    00-06-87-02-13-d4 MD6/MA06a


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 02:06AM (sysUpTime: 761379)
Total number of protection switches: 15

Ring status: idle
Ring port 0: port 1; status=Up, blocked
  MD level 6; MA name MA06a; MEP ID 61; APS VID "aps1"; RPL neighbor
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 62; APS VID "aps1"
```

RPL Neighbor is blocking the RPL (Port 1) and forwarding all traffic across Port 2 (Ring Link).

Breaking the Ring Link between Node A and D and Node D and E will cause the RPL Owners to unblock the Ring Protection Link.



To display the status of the ERPS instance for Node A, use the *rmep -s* and *erps -s* command.

```
rmep -s
Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
11    41     3   3   6   1    2001  Fail/None  00-06-87-02-14-a1 MD6/MA06
12    21     3   3   6   2    2001  OK/None    00-06-87-01-e5-c1 MD6/MA06
```

The Maintenance End Point between Node A (11) and Node D (41) indicates a failed status condition.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt", "aps1"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 12:43AM (sysUpTime: 262700)
Total number of protection switches: 18

Ring Status: protection
Ring port 0: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 12; APS VID "aps"; RPL owner
Ring port 1: port 1; status=Down, blocked
  MD level 6; MA name MA06; MEP ID 11; APS VID "aps"
```

The Ring status has changed from “idle” to “protection”, indicating a fault on the ring.

RPL Owner unblocks the RPL (Port 2) due to the failure on Port 1. Port 1 status is down and blocked. All traffic is forwarded across Port 2.

All nodes will indicate a Ring status of “protection” and will forward all traffic out all ports that have a status=Up.

To display the status of the ERPS instance for Node E, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
51    44     1   1   6   1    2002  Fail/None  00-06-87-02-14-a4 MD6/MA06a
52    61     1   1   6   2    2002  OK/None    00-06-87-01-74-e9 MD6/MA06a


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 02:49AM (sysUpTime: 1016786)
Total number of protection switches: 15

Ring status: protection
Ring port 0: port 2; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 52; APS VID "aps1"; RPL owner
Ring port 1: port 1; status=Down, blocked
  MD level 6; MA name MA06a; MEP ID 51; APS VID "aps1"
```

The Maintenance End Point between Node D (44) and Node E (51) indicates a failed status condition.

The Ring status has changed from “idle” to “protection”, indicating a fault on the ring.

RPL Owner unblocks the RPL (Port 2) due to the failure on Port 1. Port 1 status is down and blocked. All traffic is forwarded across Port 2.

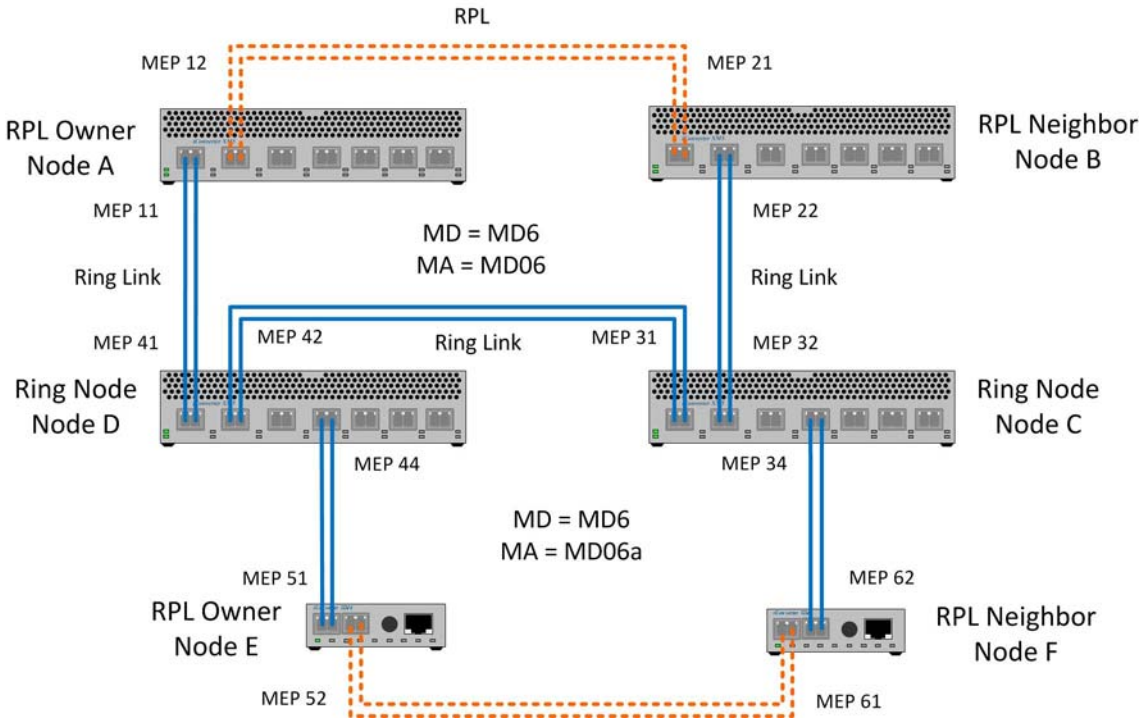
All nodes will indicate a Ring status of “protection” and will forward all traffic out all ports that have a status=Up.

Open Sub Ring

In this example, four iConverter XM5 Network Interface Devices are configured for an 802.1ag MEP-based ERPS Major Ring and two iConverter GM4 Network Interface Devices are configured for an 802.1ag MEP-based ERPS Open Sub Ring.

Node A is configured as the RPL Owner and Node B is configured as the RPL Neighbor of the Major Ring. Node E is configured as the RPL Owner and Node F is configured as the RPL Neighbor of the Sub Ring. The Owner and Neighbor is responsible for blocking the transmission and reception of traffic over the RPL. The Sub Ring will terminate at the interconnecting nodes (Node C and Node D).

IEEE 802.1ag Connectivity Fault Management is configured on each node. 3.3msec Connectivity Check Messages (CCMs) are used to ensure a 50msec protection switchover.



The following scripts configure a EVC-base ERPS 4 Node Major Ring and a 2 Node Open Sub Ring with 802.1ag.

Node A – RPL Owner
CLI Commands
l2cp -a -p all -c tunnel -n lldp l2cp -a -p all -c tunnel -n linkoam
evc -a -e data   -p 1,2,7   -v 1001 evc -a -e mgt   -p 1,2,7,mgt   -v 2000 evc -a -e aps   -p 1,2   -v 2001
interface -a -p 1   -t nni interface -a -p 2   -t nni interface -a -p 7   -t uni -e data:100 -e mgt:* interface -a -p mgt -t uni -e mgt:*
evc -ena cfm -ena all
md   -a -n MD6 -l 6 ma   -a -l 6 -o MA06 -e aps -i 1 -c 1 mep -a -l 6 -o MA06 -e aps -p 1 -m 11 -dn mep -a -l 6 -o MA06 -e aps -p 2 -m 12 -dn rmep -a -l 6 -o MA06 -m 41 -lmep 11 rmep -a -l 6 -o MA06 -m 21 -lmep 12
erps -ena erps erps -a -pn majoraps -e data -rp0 2;6,MA06,12:ro -rp1 1;6,MA06,11 -aev aps -wtrtime 1 -pri 7 erps -a -pn majoraps -e mgt erps -ena profile majoraps rev,wtr

Port 2 is configured as the RPL with the module designated as the Ring Owner (*-rp0 2:ro*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node B – RPL Neighbor

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,7       -v 1001
evc -a -e mgt    -p 1,2,7,mgt   -v 2000
evc -a -e aps    -p 1,2         -v 2001
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 7   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 21 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 22 -dn
rmep -a -l 6 -o MA06 -m 12 -lmep 21
rmep -a -l 6 -o MA06 -m 32 -lmep 22
```

```
erps -ena erps
erps -a -pn majoraps -e data -rp0 1;6,MA06,21:rn -rp1 2;6,MA06,22 -aev aps -pri 7
erps -a -pn majoraps -e mgt
erps -ena profile majoraps rev
```

Port 1 is configured as the RPL with the module designated as the Ring Neighbor (*-rp0 1:rn*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node C

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,4,7       -v 1001
evc -a -e mgt    -p 1,2,4,7,mgt   -v 2000
evc -a -e aps    -p 1,2           -v 2001
evc -a -e aps1   -p 4             -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 4   -t nni
interface -a -p 7   -t uni -e mgt:* -e data:100
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 31 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 32 -dn
rmep -a -l 6 -o MA06 -m 42 -lmep 31
rmep -a -l 6 -o MA06 -m 22 -lmep 32
##
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 4 -m 34 -dn
rmep -a -l 6 -o MA06a -m 62 -lmep 34
```

```
erps -ena erps
erps -a -pn majoraps -e data -rp0 1;6,MA06,31 -rp1 2;6,MA06,32 -aev aps -pri 7
erps -a -pn majoraps -e mgt
erps -ena profile majoraps rev
##
erps -a -pn subaps -e data -rp0 4;6,MA06a,34 -aev aps1 -rtyp open -pri 7
erps -a -pn subaps -e mgt
erps -ena profile subaps rev
```

Node C and D are interconnect node for the Sub Ring. The Sub Ring will terminate at the interconnect nodes.

A new Maintenance Association called MA06a is configured (*ma -a -o MA06a*) on the existing Maintenance Domain (MD6). The Maintenance Association is on the aps1 EVC with 3.3msec CCMs (-*i*). A Maintenance End Point is configured on Port 4 (-*p*) with a MEP identifier (-*m*) of 34 and configured as a Down MEP (-*dn*). The Maintenance End Point is associated (-*lmep*) with a Remote End Point identifier (-*m*) of 62.

```
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 4 -m 34 -dn
rmep -a -l 6 -o MA06a -m 62 -lmep 34
```

The Sub Ring ERPS command configures an open ring by not defining a Ring Port 1 (*-rp1*) connection and indicating the ring is open (*-rtyp*).

```
erps -a -pn subaps -e data -rp0 4;6,MA06a,34 -aev aps1 -rtyp open -pri 7
```

Node D

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,4,7       -v 1001
evc -a -e mgt    -p 1,2,4,7,mgt   -v 2000
evc -a -e aps    -p 1,2           -v 2001
evc -a -e aps1   -p 4             -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 4   -t nni
interface -a -p 7   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 41 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 42 -dn
rmep -a -l 6 -o MA06 -m 11 -lmep 41
rmep -a -l 6 -o MA06 -m 31 -lmep 42
##
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 4 -m 44 -dn
rmep -a -l 6 -o MA06a -m 51 -lmep 44
```

```
erps -ena erps
erps -a -pn majoraps -e data -rp0 1;6,MA06,41 -rp1 2;6,MA06,42 -aev aps -pri 7
erps -a -pn majoraps -e mgt
erps -ena profile majoraps rev
##
erps -a -pn subaps -e data -rp0 4;6,MA06a,44 -aev aps1 -rtyp open -pri 7
erps -a -pn subaps -e mgt
erps -ena profile subaps rev
```

Node E - RPL Owner

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,3         -v 1001
evc -a -e mgt    -p 1,2,3,mgt     -v 2000
evc -a -e aps    -p 1,2           -v 2001
evc -a -e aps1   -p 1,2           -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 3   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 1 -m 51 -dn
mep  -a -l 6 -o MA06a -e aps1 -p 2 -m 52 -dn
rmep -a -l 6 -o MA06a -m 44 -lmep 51
rmep -a -l 6 -o MA06a -m 61 -lmep 52
```

```
erps -ena erps
erps -a -pn subaps -e data -rp0 2;6,MA06a,52:ro -rp1 1;6,MA06a,51 -aev aps1 -pri 7 -wtrtime
1
erps -a -pn subaps -e mgt
erps -ena profile subaps rev,wtr
```

Port 2 is configured as the RPL with the module designated as the Ring Owner (*-rp0 2:ro*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node F – RPL Neighbor

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,3         -v 1001
evc -a -e mgt    -p 1,2,3,mgt     -v 2000
evc -a -e aps    -p 1,2           -v 2001
evc -a -e aps1   -p 1,2           -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 3   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 1 -m 61 -dn
mep  -a -l 6 -o MA06a -e aps1 -p 2 -m 62 -dn
rmep -a -l 6 -o MA06a -m 52 -lmep 61
rmep -a -l 6 -o MA06a -m 34 -lmep 62
```

```
erps -ena erps
erps -a -pn subaps -e data -rp0 1;6,MA06a,61:rn -rp1 2;6,MA06a,62 -aev aps1 -pri 7
erps -a -pn subaps -e mgt
erps -ena profile subaps rev
```

Port 1 is configured as the RPL with the module designated as the Ring Neighbor (*-rp0 1:rn*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

To display the status of the ERPS instance for Node A, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
11    41     1   1   6   1    2001  OK/None    00-06-87-02-14-a1 MD6/MA06
12    21     1   1   6   2    2001  OK/None    00-06-87-01-e5-c1 MD6/MA06


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 04:34PM (sysUpTime: 5966800)
Total number of protection switches: 10

Ring Status: idle
Ring port 0: port 2; status=Up, blocked
  MD level 6; MA name MA06; MEP ID 12; APS VID "aps"; RPL owner
Ring port 1: port 1; status=Up, forward
  MD level 6; MA name MA06; MEP ID 11; APS VID "aps"
```

The RMEP status indicates a good connection between the local and remote MEPs.

RPL Owner is blocking the RPL (Port 2) and forwarding all traffic across Port 1 (Ring Link).

To display the status of the ERPS instance for Node B, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
21    12     1   1   6   1    2001  OK/None    00-06-87-02-13-f2 MD6/MA06
22    32     1   1   6   2    2001  OK/None    00-06-87-02-13-d2 MD6/MA06


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 04:33PM (sysUpTime: 5967400)
Total number of protection switches: 16

Ring Status: idle
Ring port 0: port 1; status=Up, blocked
  MD level 6; MA name MA06; MEP ID 21; APS VID "aps"; RPL neighbor
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 22; APS VID "aps"
```

The RMEP status indicates a good connection between the local and remote MEPs.

RPL Neighbor is blocking the RPL (Port 1) and forwarding all traffic across Port 2 (Ring Link).

To display the status of the ERPS instance for Node C, use the *rmep -s* and *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 04:32PM (sysUpTime: 5955000)
Total number of protection switches: 7

Ring Status: idle
Ring port 0: port 1; status=Up, forward
  MD level 6; MA name MA06; MEP ID 31; APS VID "aps"
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 32; APS VID "aps"

------ Ethernet Ring Protection Switching Instance #2 -----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Open
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: n/a (sysUpTime: 0)
Total number of protection switches: 0

Ring Status: idle
Ring port 0: port 4; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 34; APS VID "aps1"
```

Node C is an interconnect node for the Sub Ring and has two ERPS instances configured.

On both rings, Node C is forwarding traffic out all ports.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
31    42     3   5   6   1    2001  OK/None    00-06-87-02-14-a2 MD6/MA06
32    22     3   5   6   2    2001  OK/None    00-06-87-01-e5-c2 MD6/MA06
34    62     3   6   6   4    2002  OK/None    00-06-87-01-74-ee MD6/MA06a
```

Node C has Maintenance End Points associated with both ERPS instances. All remote end points have an OK status with no defects.

To display the status of the ERPS instance for Node D, use the *rmep -s* and *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 04:34PM (sysUpTime: 5966100)
Total number of protection switches: 5

Ring Status: idle
Ring port 0: port 1; status=Up, forward
  MD level 6; MA name MA06; MEP ID 41; APS VID "aps"
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 42; APS VID "aps"

------ Ethernet Ring Protection Switching Instance #2 -----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Open
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 04:33PM (sysUpTime: 5964100)
Total number of protection switches: 1

Ring Status: idle
Ring port 0: port 4; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 44; APS VID "aps1"
```

Node D is an interconnect node for the Sub Ring and has two ERPS instances configured.

On both rings, Node D is forwarding traffic out all ports.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
41    11     1   1   6   1    2001  OK/None    00-06-87-02-13-f1 MD6/MA06
42    31     1   1   6   2    2001  OK/None    00-06-87-02-13-d1 MD6/MA06
44    51     1   2   6   4    2002  OK/None    00-06-87-01-af-79 MD6/MA06a
```

Node D has Maintenance End Points associated with both ERPS instances. All remote end points have an OK status with no defects.

To display the status of the ERPS instance for Node E, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
51    44     2   2   6   1    2002  OK/None    00-06-87-02-14-a4 MD6/MA06a
52    61     2   2   6   2    2002  OK/None    00-06-87-01-74-e9 MD6/MA06a


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Open
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 07:38PM (sysUpTime: 7072757)
Total number of protection switches: 5

Ring status: idle
Ring port 0: port 2; status=Up, blocked
  MD level 6; MA name MA06a; MEP ID 52; APS VID "aps1"; RPL owner
Ring port 1: port 1; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 51; APS VID "aps1"
```

The RMEP status indicates a good connection between the local and remote MEPs.

RPL Owner is blocking the RPL (Port 2) and forwarding all traffic across Port 1 (Ring Link).

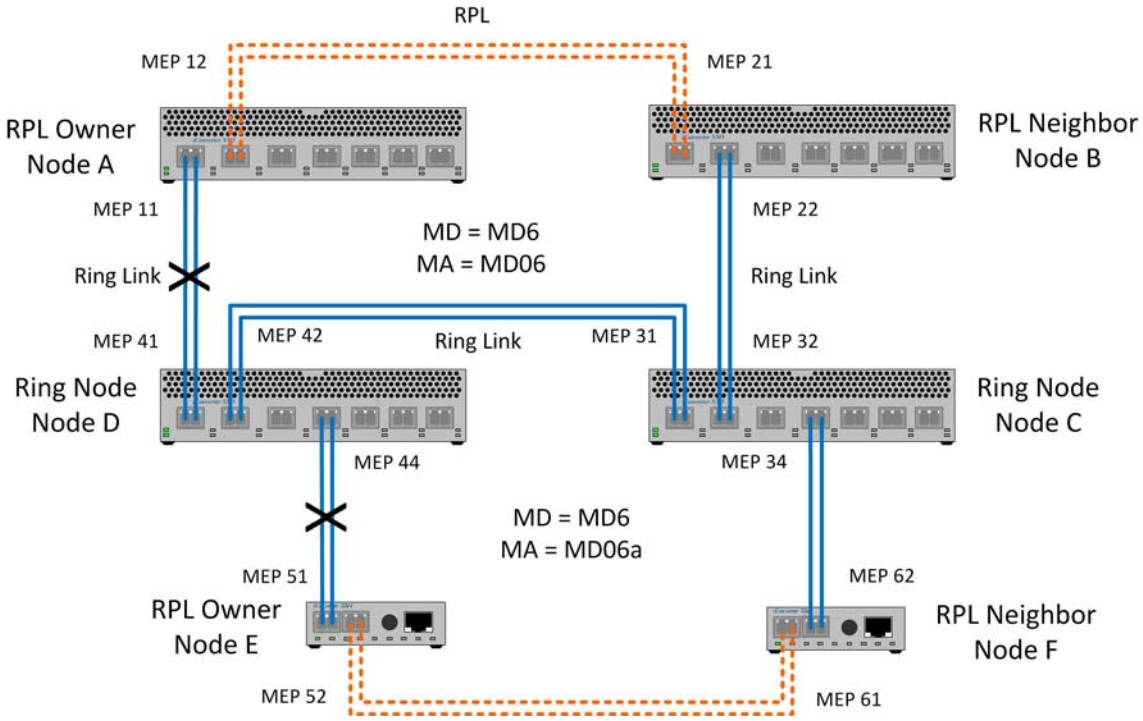
To display the status of the ERPS instance for Node F, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
61    52     4   4   6   1    2002  OK/None    00-06-87-01-af-7e MD6/MA06a
62    34     4   4   6   2    2002  OK/None    00-06-87-02-13-d4 MD6/MA06a


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Open
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 07:37PM (sysUpTime: 7064985)
Total number of protection switches: 1

Ring status: idle
Ring port 0: port 1; status=Up, blocked
  MD level 6; MA name MA06a; MEP ID 61; APS VID "aps1"; RPL neighbor
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 62; APS VID "aps1"
```

The RMEP status indicates a good connection between the local and remote MEPs.

RPL Neighbor is blocking the RPL (Port 1) and forwarding all traffic across Port 2 (Ring Link).

Breaking the Ring Link between Node A and D and Node D and E will cause the RPL Owners to unblock the Ring Protection Link.



To display the status of the ERPS instance for Node A, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
11    41     1   1   6   1    2001  Fail/None  00-06-87-02-14-a1 MD6/MA06
12    21     1   1   6   2    2001  OK/None    00-06-87-01-e5-c1 MD6/MA06
```

The Maintenance End Point between Node A (11) and Node D (41) indicates a failed status condition.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 06:01PM (sysUpTime: 6493200)
Total number of protection switches: 12

Ring Status: protection
Ring port 0: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 12; APS VID "aps"; RPL owner
Ring port 1: port 1; status=Down, blocked
  MD level 6; MA name MA06; MEP ID 11; APS VID "aps"
```

The Ring status has changed from “idle” to “protection”, indicating a fault on the ring.

RPL Owner unblocks the RPL (Port 2) due to the failure on Port 1. Port 1 status is down and blocked. All traffic is forwarded across Port 2.

All nodes will indicate a Ring status of “protection” and will forward all traffic out all ports that have a status=Up.

To display the status of the ERPS instance for Node E, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
51    44     2   2   6   1    2002  Fail/None  00-06-87-02-14-a4 MD6/MA06a
52    61     2   2   6   2    2002  OK/None    00-06-87-01-74-e9 MD6/MA06a


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Open
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 08:07PM (sysUpTime: 7247398)
Total number of protection switches: 7

Ring status: protection
Ring port 0: port 2; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 52; APS VID "aps1"; RPL owner
Ring port 1: port 1; status=Down, blocked
  MD level 6; MA name MA06a; MEP ID 51; APS VID "aps1"
```

The Maintenance End Point between Node D (44) and Node E (51) indicates a failed status condition.

The Ring status has changed from “idle” to “protection”, indicating a fault on the ring.

RPL Owner unblocks the RPL (Port 2) due to the failure on Port 1. Port 1 status is down and blocked. All traffic is forwarded across Port 2.

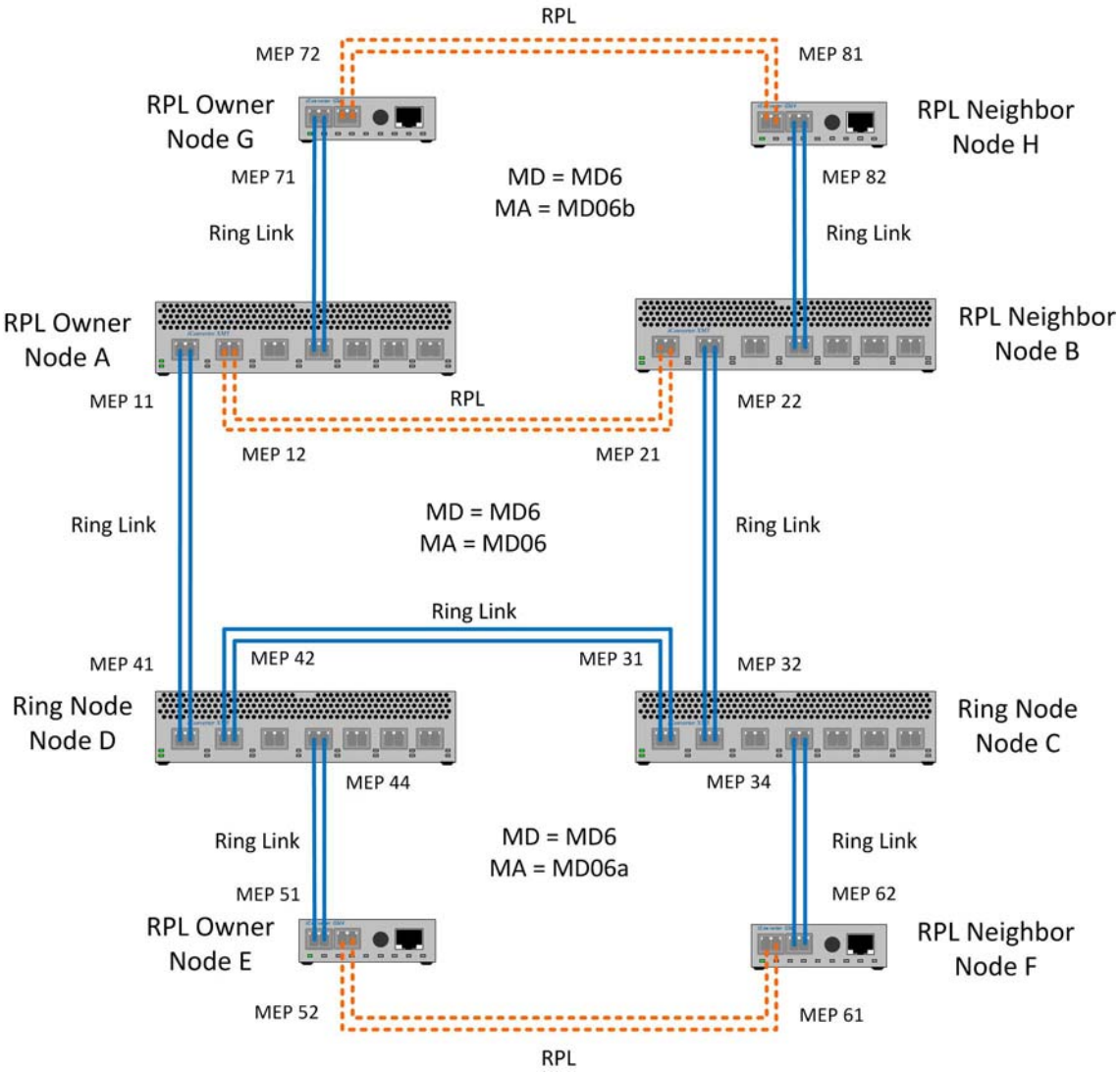
All nodes will indicate a Ring status of “protection” and will forward all traffic out all ports that have a status=Up.

Dual Closed Sub Rings with Virtual Channel

In this example, four iConverter XM5 Network Interface Devices are configured for an 802.1ag MEP-based ERPS Major Ring and four iConverter GM4 Network Interface Devices are configured for two 802.1ag MEP-based ERPS Closed Sub Rings.

Node A is configured as the RPL Owner and Node B is configured as the RPL Neighbor of the Major Ring. Node E is configured as the RPL Owner and Node F is configured as the RPL Neighbor of the Sub Ring 1 and Node G is configured as the RPL Owner and Node H is configured as the RPL Neighbor of the Sub Ring 2. The Owner and Neighbor is responsible for blocking the transmission and reception of traffic over the RPL. Virtual channels are configured on the Major Ring to close Sub Ring 1 and Sub Ring 2.

IEEE 802.1ag Connectivity Fault Management is configured on each node. 3.3msec Connectivity Check Messages (CCMs) are used to ensure a 50msec protection switchover.



The following scripts configure a 802.1ag MEP-base ERPS 4 Node Major Ring and dual 2 Node Closed Sub Ring.

Node A – RPL Owner

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,4,7       -v 1001
evc -a -e mgt    -p 1,2,4,7,mgt   -v 2000
evc -a -e aps    -p 1,2           -v 2001
evc -a -e aps1   -p 1,2           -v 2002
evc -a -e aps2   -p 1,2,4         -v 2003
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 4   -t nni
interface -a -p 7   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 11 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 12 -dn
rmep -a -l 6 -o MA06 -m 41 -lmep 11
rmep -a -l 6 -o MA06 -m 21 -lmep 12
##
ma   -a -l 6 -o MA06b -e aps2 -i 1 -c 1
mep  -a -l 6 -o MA06b -e aps2 -p 4 -m 14 -dn
rmep -a -l 6 -o MA06b -m71 -lmep 14
```

```
erps -ena erps
erps -a -pn majoraps -e data -rp0 2;6,MA06,12:ro -rp1 1;6,MA06,11 -aev aps -wtrtime 1 -pri 7
erps -a -pn majoraps -e mgt
erps -a -pn majoraps -e aps1
erps -a -pn majoraps -e aps2
erps -ena profile majoraps rev,wtr
##
erps -a -pn subaps2 -e data -rp0 4;6,MA06b,14 -rp1 vp -vdo majoraps -aev aps2 -rtyp closed
 -pri 7
erps -a -pn subaps2 -e mgt
erps -ena profile subaps2 rev
```

Port 2 is configured as the RPL of the Major Ring with the module designated as the Ring Owner (*-rp0 2:ro*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node A and B are interconnect node for the Sub Ring 2.

The interconnect nodes must support IEEE 802.1ag parameters for Sub Ring 2 and a virtual channel on the Major Ring.

A new Maintenance Association called MA06b is configured (*ma -a -o MA06b*) on the existing Maintenance Domain (MD6). The Maintenance Association is on the aps2 EVC with 3.3msec CCMs (*-i*). A Maintenance End Point is configured on Port 4 (*-p*) with a MEP identifier (*-m*) of 14 and

configured as a Down MEP (*-dn*). The Maintenance End Point is associated (*-lmep*) with a Remote End Point identifier (*-m*) of 71.

```
ma   -a -l 6 -o MA06b -e aps2 -i 1 -c 1
mep  -a -l 6 -o MA06b -e aps2 -p 4 -m 14 -dn
rmep -a -l 6 -o MA06b -m 71 -lmep 14
```

The Sub Ring ERPS command configure a virtual channel on the Major Ring using the *-rp1 vp -vdo majoraps* command and indicates the ring is closed (*-rtyp*) by the virtual channel.

```
erps -a -pn subaps1 -e data -rp0 4;6,MA06b,14 -rp1 vp -vdo majoraps -aev aps2 -rtyp closed
-pri 7
```

Node B – RPL Neighbor

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,4,7       -v 1001
evc -a -e mgt    -p 1,2,4,7,mgt   -v 2000
evc -a -e aps    -p 1,2           -v 2001
evc -a -e aps1   -p 1,2           -v 2002
evc -a -e aps2   -p 1,2,4         -v 2003
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 4   -t nni
interface -a -p 7   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 21 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 22 -dn
rmep -a -l 6 -o MA06 -m 12 -lmep 21
rmep -a -l 6 -o MA06 -m 32 -lmep 22
##
ma   -a -l 6 -o MA06b -e aps2 -i 1 -c 1
mep  -a -l 6 -o MA06b -e aps2 -p 4 -m 24 -dn
rmep -a -l 6 -o MA06b -m 82 -lmep 24
```

```
erps -ena erps
erps -a -pn majoraps -e data -rp0 1;6,MA06,21:rn -rp1 2;6,MA06,22 -aev aps -pri 7
erps -a -pn majoraps -e mgt
erps -a -pn majoraps -e aps1
erps -a -pn majoraps -e aps2
erps -ena profile majoraps rev
##
erps -a -pn subaps2 -e data -rp0 4;6,MA06b,24 -rp1 vp -vdo majoraps -aev aps2 -rtyp closed
-pri 7
erps -a -pn subaps2 -e mgt
erps -ena profile subaps2 rev
```

Port 1 is configured as the RPL of the Major Ring with the module designated as the Ring Neighbor (*-rp0 1:rn*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node C

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,4,7       -v 1001
evc -a -e mgt    -p 1,2,4,7,mgt   -v 2000
evc -a -e aps    -p 1,2           -v 2001
evc -a -e aps1   -p 1,2,4         -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 4   -t nni
interface -a -p 7   -t uni -e mgt:* -e data:100
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 31 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 32 -dn
rmep -a -l 6 -o MA06 -m 42 -lmep 31
rmep -a -l 6 -o MA06 -m 22 -lmep 32
##
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 4 -m 34 -dn
rmep -a -l 6 -o MA06a -m 62 -lmep 34
```

```
erps -ena erps
erps -a -pn majoraps -e data -rp0 1;6,MA06,31 -rp1 2;6,MA06,32 -aev aps -pri 7
erps -a -pn majoraps -e mgt
erps -a -pn majoraps -e aps1
erps -ena profile majoraps rev
##
erps -a -pn subaps -e data -rp0 4;6,MA06a,34 -rp1 vp -vdo majoraps -aev aps1 -rtyp closed -
pri 7
erps -a -pn subaps -e mgt
erps -ena profile subaps rev
```

Node C and D are interconnect node for the Sub Ring 1.

The interconnect nodes must support IEEE 802.1ag parameters for Sub Ring 1 and a virtual channel on the Major Ring.

A new Maintenance Association called MA06a is configured (*ma -a -o MA06a*) on the existing Maintenance Domain (MD6). The Maintenance Association is on the aps1 EVC with 3.3msec CCMs (-*i*). A Maintenance End Point is configured on Port 4 (-*p*) with a MEP identifier (-*m*) of 34 and configured as a Down MEP (-*dn*). The Maintenance End Point is associated (-*lmep*) with a Remote End Point identifier (-*m*) of 62.

```
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 4 -m 34 -dn
rmep -a -l 6 -o MA06a -m 62 -lmep 34
```

The Sub Ring ERPS command configure a virtual channel on the Major Ring using the *-rp1 vp -vdo majoraps* command and indicates the ring is closed (*-rtyp*) by the virtual channel.

```
erps -a -pn subaps -e data -rp0 4;6,MA06a,34 -rp1 vp -vdo majoraps -aev aps1 -rtyp closed
-pri 7
```

Node D

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,4,7       -v 1001
evc -a -e mgt    -p 1,2,4,7,mgt   -v 2000
evc -a -e aps    -p 1,2           -v 2001
evc -a -e aps1   -p 1,2,4         -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 4   -t nni
interface -a -p 7   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06 -e aps -i 1 -c 1
mep  -a -l 6 -o MA06 -e aps -p 1 -m 41 -dn
mep  -a -l 6 -o MA06 -e aps -p 2 -m 42 -dn
rmep -a -l 6 -o MA06 -m 11 -lmep 41
rmep -a -l 6 -o MA06 -m 31 -lmep 42
##
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 4 -m 44 -dn
rmep -a -l 6 -o MA06a -m 51 -lmep 44
```

```
erps -ena erps
erps -a -pn majoraps -e data -rp0 1;6,MA06,41 -rp1 2;6,MA06,42 -aev aps -pri 7
erps -a -pn majoraps -e mgt
erps -a -pn majoraps -e aps1
erps -ena profile majoraps rev
##
erps -a -pn subaps -e data -rp0 4;6,MA06a,44 -rp1 vp -vdo majoraps -aev aps1 -rtyp closed -
pri 7
erps -a -pn subaps -e mgt
erps -ena profile subaps rev
```

Node E - RPL Owner

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,3         -v 1001
evc -a -e mgt    -p 1,2,3,mgt     -v 2000
evc -a -e aps1   -p 1,2           -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 3   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 1 -m 51 -dn
mep  -a -l 6 -o MA06a -e aps1 -p 2 -m 52 -dn
rmep -a -l 6 -o MA06a -m 44 -lmep 51
rmep -a -l 6 -o MA06a -m 61 -lmep 52
```

```
erps -ena erps
erps -a -pn subaps -e data -rp0 2;6,MA06a,52:ro -rp1 1;6,MA06a,51 -aev aps1 -pri 7
-wtrtime 1
erps -a -pn subaps -e mgt
erps -ena profile subaps rev,wtr
```

Port 2 is configured as the RPL of the Sub Ring 1 with the module designated as the Ring Owner (*-rp0 2:ro*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node F – RPL Neighbor

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,3         -v 1001
evc -a -e mgt    -p 1,2,3,mgt     -v 2000
evc -a -e aps1   -p 1,2           -v 2002
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 3   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06a -e aps1 -i 1 -c 1
mep  -a -l 6 -o MA06a -e aps1 -p 1 -m 61 -dn
mep  -a -l 6 -o MA06a -e aps1 -p 2 -m 62 -dn
rmep -a -l 6 -o MA06a -m 52 -lmep 61
rmep -a -l 6 -o MA06a -m 34 -lmep 62
```

```
erps -ena erps
erps -a -pn subaps -e data -rp0 1;6,MA06a,61:rn -rp1 2;6,MA06a,62 -aev aps1 -pri 7
erps -a -pn subaps -e mgt
erps -ena profile subaps rev
```

Port 1 is configured as the RPL of the Sub Ring 1 with the module designated as the Ring Neighbor (*-rp0 1:rn*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node G - RPL Owner

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,3         -v 1001
evc -a -e mgt    -p 1,2,3,mgt     -v 2000
evc -a -e aps2   -p 1,2           -v 2003
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 3   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06b -e aps2 -i 1 -c 1
mep  -a -l 6 -o MA06b -e aps2 -p 1 -m 71 -dn
mep  -a -l 6 -o MA06b -e aps2 -p 2 -m 72 -dn
rmep -a -l 6 -o MA06b -m 14 -lmep 71
rmep -a -l 6 -o MA06b -m 81 -lmep 72
```

```
erps -ena erps
erps -a -pn subaps -e data -rp0 2;6,MA06b,72:ro -rp1 1;6,MA06b,71 -aev aps2 -pri 7
-wtrtime 1
erps -a -pn subaps -e mgt
erps -ena profile subaps rev,wtr
```

Port 2 is configured as the RPL of the Sub Ring 2 with the module designated as the Ring Owner (*-rp0 2:ro*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

Node H – RPL Neighbor

CLI Commands

```
l2cp -a -p all -c tunnel -n lldp
l2cp -a -p all -c tunnel -n linkoam
```

```
evc -a -e data   -p 1,2,3         -v 1001
evc -a -e mgt    -p 1,2,3,mgt     -v 2000
evc -a -e aps2   -p 1,2           -v 2003
```

```
interface -a -p 1   -t nni
interface -a -p 2   -t nni
interface -a -p 3   -t uni -e data:100 -e mgt:*
interface -a -p mgt -t uni -e mgt:*
```

```
evc -ena
cfm -ena all
```

```
md   -a -n MD6 -l 6
ma   -a -l 6 -o MA06b -e aps2 -i 1 -c 1
mep  -a -l 6 -o MA06b -e aps2 -p 1 -m 81 -dn
mep  -a -l 6 -o MA06b -e aps2 -p 2 -m 82 -dn
rmep -a -l 6 -o MA06b -m 72 -lmep 81
rmep -a -l 6 -o MA06b -m 24 -lmep 82
```

```
erps -ena erps
erps -a -pn subaps -e data -rp0 1;6,MA06b,81:rn -rp1 2;6,MA06b,82 -aev aps2 -pri 7
erps -a -pn subaps -e mgt
erps -ena profile subaps rev
```

Port 1 is configured as the RPL of the Sub Ring 2 with the module designated as the Ring Neighbor (*-rp0 1:rn*). Ring Port 1 and 2 are also configured with *md,ma,mep* parameters.

To display the status of the ERPS instances for Node A, use the *rmep -s* and *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt", "aps1", "aps2"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 2, 2000 10:42PM (sysUpTime: 16817500)
Total number of protection switches: 14

Ring Status: idle
Ring port 0: port 2; status=Up, blocked
  MD level 6; MA name MA06; MEP ID 12; APS VID "aps"; RPL owner
Ring port 1: port 1; status=Up, forward
  MD level 6; MA name MA06; MEP ID 11; APS VID "aps"

------ Ethernet Ring Protection Switching Instance #2 -----------------------
Profile name: subaps2
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 2, 2000 10:56PM (sysUpTime: 16898600)
Total number of protection switches: 1

Ring Status: idle
Ring port 0: port 4; status=Up, forward
  MD level 6; MA name MA06b; MEP ID 14; APS VID "aps2"
Ring port 1: virtual port: virtual domain "majoraps"
```

RPL Owner of the Major Ring is blocking the RPL (Port 2) and forwarding all traffic across Port 1 (Ring Link). Node A is an interconnect node for the Sub Ring 2 and is forwarding traffic out Port 4.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
11    41     4   5   6   1    2001  OK/None    00-06-87-02-14-a1 MD6/MA06
12    21     4   5   6   2    2001  OK/None    00-06-87-01-e5-c1 MD6/MA06
14    71     4   6   6   4    2003  OK/None    00-06-87-01-5f-a9 MD6/MA06b
```

Node A has Maintenance End Points associated for both the Major Ring and Sub Ring 2. The RMEP status for both rings indicate a good connection between the local and remote MEPs.

To display the status of the ERPS instances for Node B, use the *rmep -s* and *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt", "aps1", "aps2"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 2, 2000 10:41PM (sysUpTime: 16812400)
Total number of protection switches: 10

Ring Status: idle
Ring port 0: port 1; status=Up, blocked
  MD level 6; MA name MA06; MEP ID 21; APS VID "aps"; RPL neighbor
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 22; APS VID "aps"

------ Ethernet Ring Protection Switching Instance #2 -----------------------
Profile name: subaps2
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 2, 2000 10:54PM (sysUpTime: 16891300)
Total number of protection switches: 3

Ring Status: idle
Ring port 0: port 4; status=Up, forward
  MD level 6; MA name MA06b; MEP ID 24; APS VID "aps2"
Ring port 1: virtual port: virtual domain "majoraps"
```

RPL Neighbor of the Major Ring is blocking the RPL (Port 1) and forwarding all traffic across Port 2 (Ring Link). Node B is an interconnect node for the Sub Ring 2 and is forwarding traffic out Port 4.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
21    12     2   2   6   1    2001  OK/None    00-06-87-02-13-f2 MD6/MA06
22    32     2   2   6   2    2001  OK/None    00-06-87-02-13-d2 MD6/MA06
24    82     2   4   6   4    2003  OK/None    00-06-87-01-5f-b6 MD6/MA06b
```

Node B has Maintenance End Points associated for both the Major Ring and Sub Ring 2. The RMEP status for both rings indicate a good connection between the local and remote MEPs.

To display the status of the ERPS instance for Node C, use the *rmep -s* and *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt", "aps1"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 2, 2000 11:30PM (sysUpTime: 17106900)
Total number of protection switches: 13

Ring Status: idle
Ring port 0: port 1; status=Up, forward
  MD level 6; MA name MA06; MEP ID 31; APS VID "aps"
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 32; APS VID "aps"

------ Ethernet Ring Protection Switching Instance #2 -----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: n/a (sysUpTime: 0)
Total number of protection switches: 0

Ring Status: idle
Ring port 0: port 4; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 34; APS VID "aps1"
Ring port 1: virtual port: virtual domain "majoraps"
```

Node C is an interconnect node for the Sub Ring 1 and has two ERPS instances configured.

On both rings, Node C is forwarding traffic out all ports.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
=============================================================================
31    42     4   7   6   1    2001  OK/None    00-06-87-02-14-a2 MD6/MA06
32    22     4   7   6   2    2001  OK/None    00-06-87-01-e5-c2 MD6/MA06
34    62     4   8   6   4    2002  OK/None    00-06-87-01-74-ee MD6/MA06a
```

Node C has Maintenance End Points associated for both the Major Ring and Sub Ring 1. The RMEP status indicates a good connection between the local and remote MEPs.

To display the status of the ERPS instance for Node D, use the *rmep -s* and *erps -s* command.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt", "aps1"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 2, 2000 11:38PM (sysUpTime: 17152000)
Total number of protection switches: 9

Ring Status: idle
Ring port 0: port 1; status=Up, forward
  MD level 6; MA name MA06; MEP ID 41; APS VID "aps"
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 42; APS VID "aps"

------ Ethernet Ring Protection Switching Instance #2 ----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 2, 2000 11:30PM (sysUpTime: 17105800)
Total number of protection switches: 1

Ring Status: idle
Ring port 0: port 4; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 44; APS VID "aps1"
Ring port 1: virtual port: virtual domain "majoraps"
```

Node D is an interconnect node for the Sub Ring 1 and has two ERPS instances configured.

On both rings, Node D is forwarding traffic out all ports.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
=============================================================================
41    11     2   3   6   1    2001  OK/None    00-06-87-02-13-f1 MD6/MA06
42    31     2   3   6   2    2001  OK/None    00-06-87-02-13-d1 MD6/MA06
44    51     2   4   6   4    2002  OK/None    00-06-87-01-af-79 MD6/MA06a
```

Node D has Maintenance End Points associated with both the Major Ring and Sub Ring 1. The RMEP status indicates a good connection between the local and remote MEPs.

To display the status of the ERPS instance for Node E, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
51    44     3   3   6   1    2002  OK/None    00-06-87-02-14-a4 MD6/MA06a
52    61     3   3   6   2    2002  OK/None    00-06-87-01-74-e9 MD6/MA06a


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 3, 2000 01:39AM (sysUpTime: 17877006)
Total number of protection switches: 5

Ring status: idle
Ring port 0: port 2; status=Up, blocked
  MD level 6; MA name MA06a; MEP ID 52; APS VID "aps1"; RPL owner
Ring port 1: port 1; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 51; APS VID "aps1"
```

The RMEP status indicates a good connection between the local and remote MEPs.

RPL Owner of Sub Ring 1 is blocking the RPL (Port 2) and forwarding all traffic across Port 1 (Ring Link).

To display the status of the EPRS instance for Node F, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
61    52     5   5   6   1    2002  OK/None    00-06-87-01-af-7e MD6/MA06a
62    34     5   5   6   2    2002  OK/None    00-06-87-02-13-d4 MD6/MA06a


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 3, 2000 01:39AM (sysUpTime: 17875240)
Total number of protection switches: 3

Ring status: idle
Ring port 0: port 1; status=Up, blocked
  MD level 6; MA name MA06a; MEP ID 61; APS VID "aps1"; RPL neighbor
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 62; APS VID "aps1"
```

The RMEP status indicates a good connection between the local and remote MEPs.

RPL Neighbor of Sub Ring 1 is blocking the RPL (Port 1) and forwarding all traffic across Port 2 (Ring Link).

To display the status of the ERPS instance for Node G, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
71    14     2   2   6   1    2003  OK/None    00-06-87-02-13-f4 MD6/MA06b
72    81     2   2   6   2    2003  OK/None    00-06-87-01-5f-b1 MD6/MA06b


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 04:56AM (sysUpTime: 1776765)
Total number of protection switches: 7

Ring status: idle
Ring port 0: port 2; status=Up, blocked
  MD level 6; MA name MA06b; MEP ID 72; APS VID "aps2"; RPL owner
Ring port 1: port 1; status=Up, forward
  MD level 6; MA name MA06b; MEP ID 71; APS VID "aps2"
```

The RMEP status indicates a good connection between the local and remote MEPs.

RPL Owner of Sub Ring 2 is blocking the RPL (Port 2) and forwarding all traffic across Port 1 (Ring Link).

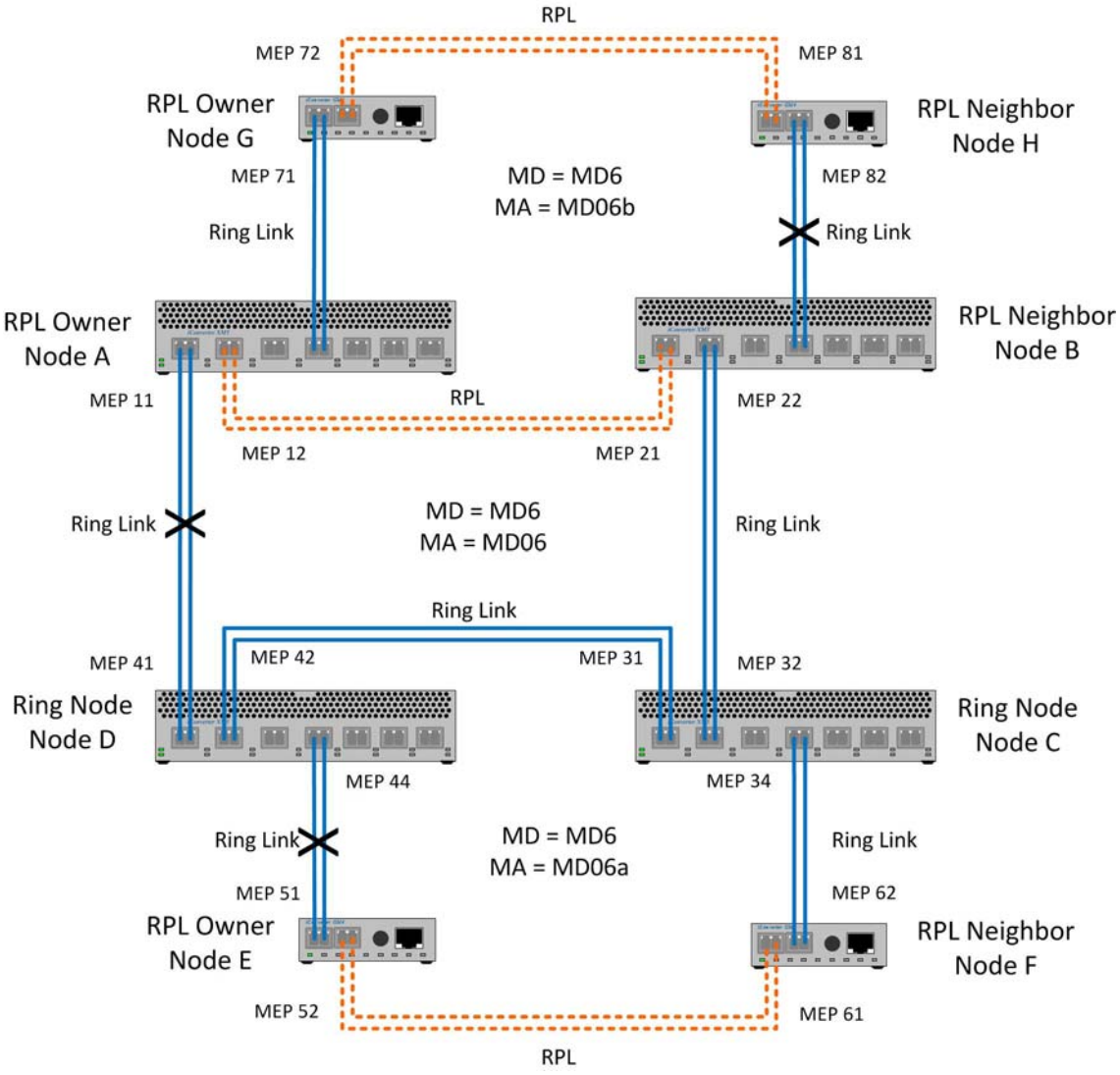
To display the status of the EPRS instance for Node H, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
61    52     5   5   6   1    2002  OK/None    00-06-87-01-af-7e MD6/MA06a
62    34     5   5   6   2    2002  OK/None    00-06-87-02-13-d4 MD6/MA06a


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 ----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 3, 2000 01:39AM (sysUpTime: 17875240)
Total number of protection switches: 3

Ring status: idle
Ring port 0: port 1; status=Up, blocked
  MD level 6; MA name MA06a; MEP ID 61; APS VID "aps1"; RPL neighbor
Ring port 1: port 2; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 62; APS VID "aps1"
```

The RMEP status indicates a good connection between the local and remote MEPs.

RPL Neighbor of Sub Ring 2 is blocking the RPL (Port 1) and forwarding all traffic across Port 2 (Ring Link).

Breaking the Ring Link between Node A and D, Node D and E and Node B and H will cause the RPL Owners to unblock the Ring Protection Link.



To display the status of the ERPS instance for Node A, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
11    41     4   5   6   1    2001  Fail/None  00-00-00-00-00-00 MD6/MA06
12    21     4   5   6   2    2001  OK/None    00-06-87-01-e5-c1 MD6/MA06
14    71     4   6   6   4    2003  OK/None    00-06-87-01-5f-a9 MD6/MA06b
```

The Maintenance End Point between Node A (11) and Node D (41) indicates a failed status condition.

```
erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: majoraps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt", "aps1", "aps2"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 12:00AM (sysUpTime: 4600)
Total number of protection switches: 10

Ring Status: protection
Ring port 0: port 2; status=Up, forward
  MD level 6; MA name MA06; MEP ID 12; APS VID "aps"; RPL owner
Ring port 1: port 1; status=Down, blocked
  MD level 6; MA name MA06; MEP ID 11; APS VID "aps"

------ Ethernet Ring Protection Switching Instance #2 -----------------------
Profile name: subaps2
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: disabled, 5 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: n/a (sysUpTime: 0)
Total number of protection switches: 0

Ring Status: protection
Ring port 0: port 4; status=Up, forward
  MD level 6; MA name MA06b; MEP ID 14; APS VID "aps2"
Ring port 1: virtual port: virtual domain "majoraps"
```

The Ring status has changed from “idle” to “protection”, indicating a fault on both rings.

RPL Owner unblocks the RPL (Port 2) due to the failure on Port 1. Port 1 status is down and blocked. All traffic is forwarded across Port 2.

All nodes will indicate a Ring status of “protection” and will forward all traffic out all ports that have a status=Up.

To display the status of the ERPS instance for Node E, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
51    44     3   3   6   1    2002  Fail/None  00-06-87-02-14-a4 MD6/MA06a
52    61     3   3   6   2    2002  OK/None    00-06-87-01-74-e9 MD6/MA06a


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 12:07AM (sysUpTime: 44722)
Total number of protection switches: 9

Ring status: protection
Ring port 0: port 2; status=Up, forward
  MD level 6; MA name MA06a; MEP ID 52; APS VID "aps1"; RPL owner
Ring port 1: port 1; status=Down, blocked
  MD level 6; MA name MA06a; MEP ID 51; APS VID "aps1"
```

The Maintenance End Point between Node D (44) and Node E (51) indicates a failed status condition.

The Ring status has changed from “idle” to “protection”, indicating a fault on the ring.

RPL Owner unblocks the RPL (Port 2) due to the failure on Port 1. Port 1 status is down and blocked. All traffic is forwarded across Port 2.

All nodes will indicate a Ring status of “protection” and will forward all traffic out all ports that have a status=Up.

To display the status of the ERPS instance for Node G, use the *rmep -s* and *erps -s* command.

```
rmep -s

Auto learning is disabled

Local Remote MD  MA  MD  Port Vlan  Status/    MAC               Domain Name/
MEPID MEPID  Idx Idx Lvl Num  Id    Defect     Addr              Maint Assoc
================================================================================
71    14     2   2   6   1    2003  OK/None    00-06-87-02-13-f4 MD6/MA06b
72    81     2   2   6   2    2003  OK/None    00-06-87-01-5f-b1 MD6/MA06b


erps -s

ERPS Protocol: enabled

------ Ethernet Ring Protection Switching Instance #1 -----------------------
Profile name: subaps
Ring Id: 1
Ring Status: Operational
Protection Instance: Enabled
Revertive: Enabled
Ring type: Closed
APS frame transmission rate: 5 sec; number of APS frames at switch: 3
Wait-to-Restore timer: enabled, 1 min
Wait-to-Block timer: disabled, 5 sec
Hold-Off timer: disabled, 0 ms
Guard timer: disabled, 500 ms
Protected traffic channel: EVC "data", "mgt"
R-APS Frame Priority: 7, domain level 6

Last protection switch: Jan 1, 2000 12:07AM (sysUpTime: 45230)
Total number of protection switches: 8

Ring status: protection
Ring port 0: port 2; status=Up, forward
  MD level 6; MA name MA06b; MEP ID 72; APS VID "aps2"; RPL owner
Ring port 1: port 1; status=Up, forward
  MD level 6; MA name MA06b; MEP ID 71; APS VID "aps2"
```

No Maintenance End Points are indicating a fault condition on the RPL Owner

The Ring status has changed from “idle” to “protection”, indicating there is a fault on the ring.

RPL Owner unblocks the RPL (Port 2) due to the failure on Port 1. Port 1 status is down and blocked. All traffic is forwarded across Port 2.

All nodes will indicate a Ring status of “protection” and will forward all traffic out all ports that have a status=Up.