G.8032 Ethernet Ring Protection Single Ring Topology

In This Chapter

This section provides information about G.8032 Ethernet ring protection single ring topology.

Topics in this section include:

Applicability

This example is applicable to the 7950 XRS (as of 10.0.R4), the 7750 SR-7/12 and 7450 ESS-7/12 (as of 9.0.R1), and the 7450 ESS-6/6v with IOM3-XP or IMM and 7750 SR-c4/12 (as of 11.0.R1). It is not supported on a 7750 SR-1, 7450 ESS-1, 7710 SR, or using an IOM-2 or lower.

The configuration was tested on release 12.0.R5, and covers ring protection for a single ring. Protection for multiple ring topologies is covered in G.8032 Ethernet Ring Protection Multiple Ring Topology on page 1883.

Overview

G.8032 Ethernet ring protection is supported for data service SAPs within a regular VPLS service, a PBB VPLS (I/B-component) or a routed VPLS (R-VPLS). G.8032 is one of the fastest protection schemes for Ethernet networks.

ITU-T G.8032v2 specifies protection switching mechanisms and a protocol for Ethernet layer network (ETH) Ethernet rings. Ethernet rings can provide wide-area multi-point connectivity more economically due to their reduced number of links. The mechanisms and protocol defined in ITU-T G.8032v2 achieve highly reliable and stable protection and never form loops, which would negatively affect network operation and service availability. Each ring node is connected to adjacent nodes participating in the same ring using two independent paths, which use ring links (configured on ports or LAGs). A ring link is bounded by two adjacent nodes and a port for a ring link is called a ring port. The minimum number of nodes on a ring is two.

The fundamentals of this ring protection switching architecture are:

- the principle of loop avoidance and
- the utilization of learning, forwarding, and address table mechanisms defined in the ITU-T G.8032v2 Ethernet flow forwarding function (ETH_FF) (Control plane).

Loop avoidance in the ring is achieved by guaranteeing that, at any time, traffic may flow on all but one of the ring links. This particular link is called the Ring Protection Link (RPL) and under normal conditions this link is blocked, so it is not used for traffic. One designated node, the RPL Owner, is responsible to block traffic over the one designated RPL. Under a ring failure condition, the RPL Owner is responsible for unblocking the RPL, allowing the RPL to be used for traffic. The protocol ensures that even without an RPL owner defined, one link will be blocked and it operates as a "break before make protocol", specifically the protocol guarantees that no link is restored until a different link in the ring is blocked. The other side of the RPL is configured as an RPL neighbor. An RPL neighbor blocks traffic on the link.

The event of a ring link or ring node failure results in protection switching of the traffic. This is achieved under the control of the ETH_FF functions on all ring nodes. A Ring Automatic Protection Switching (R-APS) protocol is used to coordinate the protection actions over the ring. The protection switching mechanisms and protocol supports a multi-ring/ladder network that consists of connected Ethernet rings, however, that is not covered in this example.

Ring Protection Mechanism

The Ring Protection protocol is based on the following building blocks:

- Ring status change on failure
    - ç   Idle -> Link failure -> Protection -> Recovery -> Idle
- Ring Control State changes
    - ç   Idle -> Protection -> Manual Switch -> Forced Switch -> Pending
- Re-use existing ETH OAM
    - ç   Monitoring : ETH Continuity Check messages
    - ç   Failure Notification : Y.1731 Signal Failure
- Forwarding Database MAC Flush on ring status change
- RPL (Ring Protection Link)
    - ç   Defines blocked link in idle status

Figure 290 shows a ring of six nodes, with the RPL owner on the top right. One link of the RPL owner is designated to be the RPL and will be blocked in order to prevent a loop. Schematics of the physical and logical topologies are also shown.

When an RPL owner and RPL end are configured, the associated link will be the RPL when the ring is fully operational and so be blocked by the RPL owner. If a different ring link fails then the RPL will be unblocked by the RPL owner. When the failed link recovers, it will initially be blocked by one of its adjacent nodes. The adjacent node sends an R-APS message across the ring to indicate the error is cleared and after a configurable time, if reversion is enabled, the RPL will revert to being blocked with all other links unblocked. This ensures that the ring topology is predictable when fully operational.

If a specific RPL owner is not configured, then the last link to become active will be blocked and the ring will remain in this state until another link fails. However, this operation makes the selection of the blocked link non-deterministic.
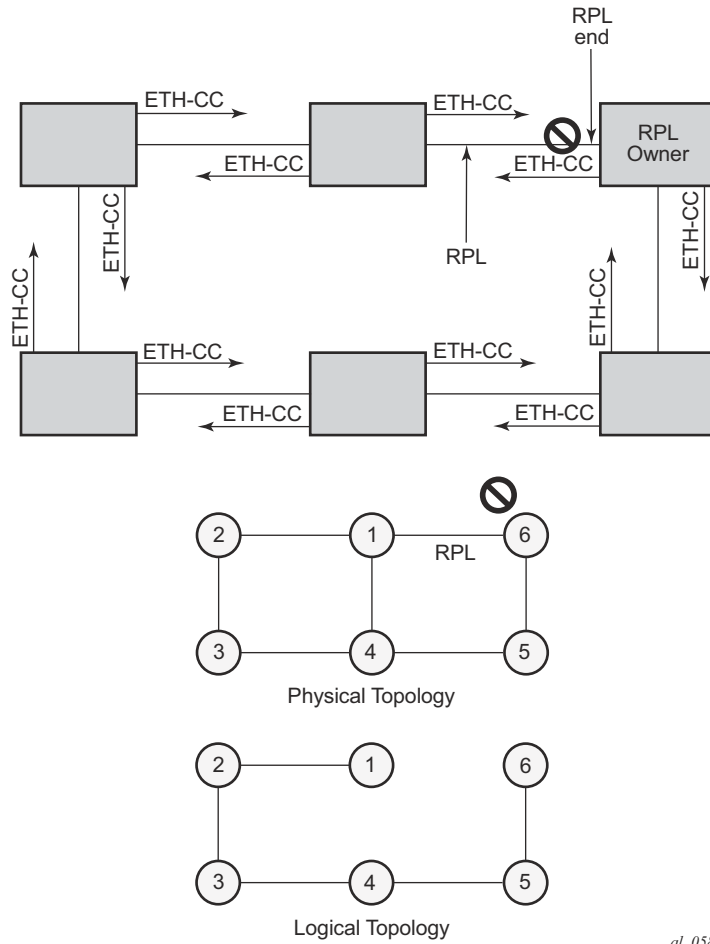
Figure 290: G.8032 Operation and Topologies

The protection protocol uses a specific control VLAN, with the associated data VLANs taking their forwarding state from the control VLAN.

Configuration

The test topology is shown in Figure 291.
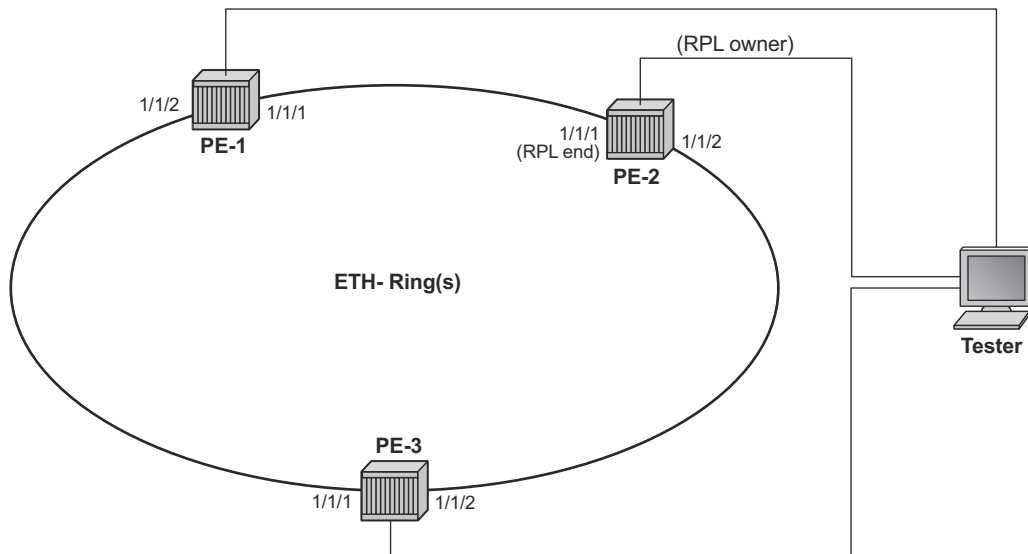
** Control Channel: VPLS 10, Tag 1
** Data Channel: VPLS 100, Tag 100

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Figure 291: Test Topology

The **eth-ring** configuration commands are shown below.

```
configure
    eth-ring <ring-index>
        ccm-hold-time { [down <down-timeout>] [up <up-timeout>] }
        compatible-version <version>
        description <description-string>
        guard-time <time>
        node-id <xx:xx:xx:xx:xx:xx or xx-xx-xx-xx-xx-xx>
        path {a|b} [ { <port-id>|<lag-id> } raps-tag <qtag>[.<qtag>] ]
            description <description-string>
            eth-cfm
                mep <mep-id> domain <md-index> association <ma-index>
                ...
            rpl-end
            shutdown
        revert-time <time>
        rpl-node {owner|nbr}
        shutdown
```

Parameters:

- *ring-index* — This is the number by which the ring is referenced, values: 1 to128.
- **ccm-hold-time** {[down <*down-timeout*>] [up <*up-timeout*>]}

    ç   down — This command specifies the timer that controls the delay between detecting that ring path is down and reporting it to the G.8032 protection module. If a non-zero value is configured, the system will wait for the time specified in the value parameter before reporting it to the G.8032 protection module. Note that this parameter applies only to ring path CCM. It does *not* apply to the ring port link state. To dampen ring port link state transitions, use the hold-time parameter from the physical member port. This is useful if the underlying path between two nodes is going across an optical system which implements its own protection.

    ç   up — This command specifies the timer which controls the delay between detecting that ring path is up and reporting it to the G.8032 protection module. If a non-zero value is configured, the system will wait for the time specified in the value parameter before reporting it to the G.8032 protection module. Note that this parameter applies only to ring path CCM. It does *not* apply to the member port link state. To dampen member port link state transitions, use the hold-time parameter from the physical member port.

    Values: <down-timeout>   : [0..5000] in deciseconds - Default: 0
    <up-timeout>   : [0..5000] in deciseconds - Default: 20
    1 centisecond = 10ms
    1 decisecond = 100ms

- compatible version — This command configures eth-ring compatibility version for the G.8032 state machine and messages. The default is version 2 (ITU G.8032v2) and all 7x50 systems use version 2. If there is a need to interwork with third party devices that only support version 1, this can be set to version 1 allowing the reception of version 1 PDUs. Note that version 2 is encoded as 1 in the R-APS messages. Compatibility allows the reception of version 1 (encoded as 0) R-APS PDUs but, as per the G.8032 specification, higher versions are ignored on reception. For the SR/ESS, messages are always originated with version 2. Therefore if a third party switch supported version 3 (encoded as 2) or higher interworking is also supported provided the other switch is compatible with version 2.

- description <description-string> — This configures a text string, up to 80 characters, which can be used to describe the use of the eth-ring.

- guard-time <time> — The forwarding method, in which R-APS messages are copied and forwarded at every Ethernet ring node, can result in a message corresponding to an old request, that is no longer relevant, being received by Ethernet ring nodes. Reception of an old R-APS message may result in erroneous ring state interpretation by some Ethernet ring nodes. 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. Messages are not forwarded when the guard-timer is running.

Values: [1..20] in deciseconds - Default: 5
1 decisecond = 100ms

- node-id <xx:xx:xx:xx:xx:xx or xx-xx-xx-xx-xx-xx> — This allows the node identifier to be explicitly configured. By default the chassis MAC is used. It is not required in typical configurations.

- path {a|b} [{<port-id>|<lag-id>} raps-tag <qtag>[.<qtag>]] — This parameter defines the paths around the ring, of which there are two in different directions on the ring: an "a" path and a "b" path. In addition it configures the encapsulation used for the R-APS messages on the ring. These can be either single or double tagged.

    ç description <description-string> — This configures a text string, up to 80 characters, which can be used to describe the use of the path.

    ç eth-cfm — Configures the associated Ethernet CFM parameters.

        - mep <mep-id> domain <md-index> association <ma-index> — The MEP defined under the path is used for the G.8032 protocol messages, which are based on IEEE 802.1ag/Y.1731 CFM frames.

    ç rpl-end — When configured, this path is expected to be one end of the RPL. This parameter must be configured in conjunction with the **rpl-node**.

    ç shutdown — This command shuts down the path.

- revert-time <time> — This command configures the revert time for an Eth-Ring. Revert time is the time that the RPL will wait before returning to the blocked state. Configuring "no revert-time" disables reversion, effectively setting the revert-time to zero.

  Values: [60..720] in seconds - Default: 300

- rpl-node {owner|nbr} — A node can be designated as either the owner of the RPL, in which case this node is responsible for the RPL, or the nbr, in which case this node is expected to be the neighbor to the RPL owner across the RPL. The nbr is optional and is included to be compliant with the specification. This parameter must be configured in conjunction with the **rpl-end** parameter.

- shutdown — This command shuts down the ring.

Prerequisites

Create following log-id on PE-2 to see major events logged to the console on PE-2.

```
configure
    log
        log-id 1
            from main
            to console
        exit
```

To configure R-APS, there should be at least 2 VPLS services for 1 Eth-Ring instance, one for the control channel and the other (or more) for data channel(s). The control channel is used for R-APS signaling while data channel is for user data traffic. The state of the data channels is inherited from the state of the control channel.

Step 0. Configuring the encapsulation for each ring port

Eth-Ring needs R-APS tags to send and receive G.8032 signaling messages. To configure a control channel, an access SAP configuration is required on each path a/b port. The SAP configuration follows that of the port and must be either *dot1q* or *qinq*, consequently the control and data packets are either single tagged or double tagged. It is also possible to have the control VPLS using single tagged frames with the data VPLSs using double tagged framed; this requires the system to be configured with the **new-qinq-untagged-sap** parameter (**configure system ethernet new-qinq-untagged-sap**), with the ring path raps-tags and control VPLS SAPs configured as qtag.0, and the data VPLSs configured as QinQ SAPs.

In this example single tags are used so the commands for ring node PE-1 are:

```
*A:PE-1# configure port 1/1/1 ethernet mode access
*A:PE-1# configure port 1/1/2 ethernet mode access
*A:PE-1# configure port 1/1/1 ethernet encap-type dot1q
*A:PE-1# configure port 1/1/2 ethernet encap-type dot1q
```

Step 1. Configuring ETH-CFM

Ethernet Ring requires Eth-CFM domain(s), association(s) and MEP(s) being configured. The domain format should be none and association name should be icc-based (Y.1731). The minimum CCM interval for the 7x50 is 10ms. The eth-ring MEP requires sub-second CCM interval (10ms or 100ms) to be configured (or 1 second from 11.0.R1 or later).

Note that the MEPs used for R-APS control normally will have CCM configured on the control channel path MEPs for failure detection. Alternatively, detecting a failure of the ring may be achieved by running Ethernet in the First Mile (EFM) at the port level if CCM is not possible at 100ms or 10ms (or 1 second as of release 11.0.R1). Loss-of-signal, in conjunction with other OAM, is applicable only when the nodes are directly connected.

To omit the failure detecting CCMs, it would be necessary to remove the *ccm-enable* from under the path MEPs and to remove the *remote-mepids* from under the *eth-cfm associations* on all nodes.

shows the Ethernet CFM configuration used here.
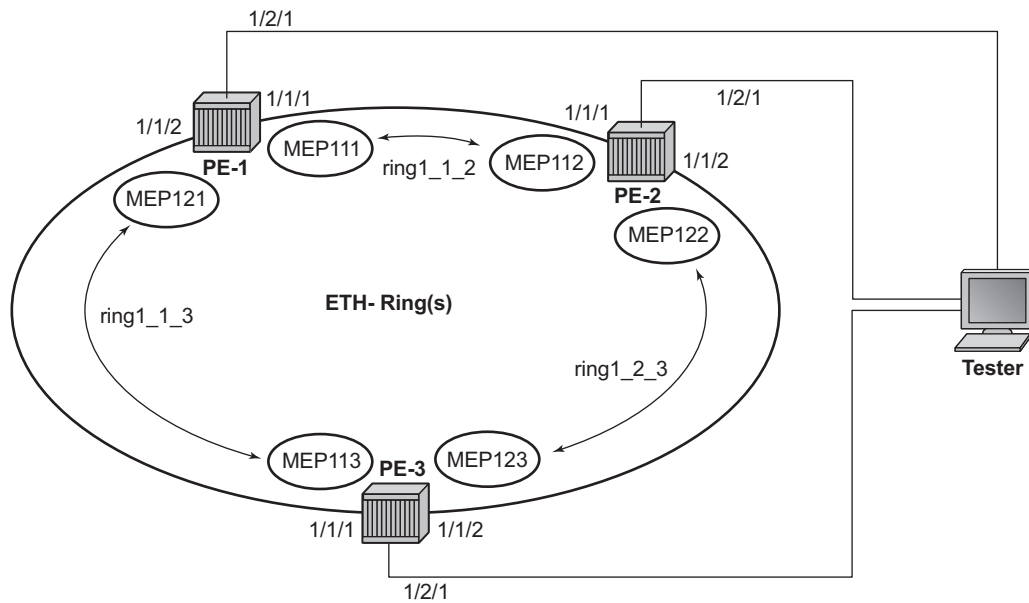
Figure 292: Ethernet CFM Configuration

The configuration of each node is as follows.

PE-1:

```
*A:PE-1>config>eth-cfm# info
----------------------------------------------
        domain 1 format none level 3
            association 1 format icc-based name "ring1_1_2"
                ccm-interval 1
                remote-mepid 112
            exit
            association 2 format icc-based name "ring1_1_3"
                ccm-interval 1
                remote-mepid 113
            exit
        exit
----------------------------------------------
*A:PE-1>config>eth-cfm#
```

PE-2:

```
A:PE-2>config>eth-cfm# info
----------------------------------------------
        domain 1 format none level 3
            association 1 format icc-based name "ring1_1_2"
                ccm-interval 1
                remote-mepid 111
            exit
            association 2 format icc-based name "ring1_2_3"
                ccm-interval 1
                remote-mepid 123
            exit
        exit
----------------------------------------------
A:PE-2>config>eth-cfm#
```

PE-3:

```
A:PE-3>config>eth-cfm# info
----------------------------------------------
        domain 1 format none level 3
            association 1 format icc-based name "ring1_1_3"
                ccm-interval 1
                remote-mepid 121
            exit
            association 2 format icc-based name "ring1_2_3"
                ccm-interval 1
                remote-mepid 122
            exit
        exit
----------------------------------------------
A:PE-3>config>eth-cfm#
```

Step 2. Configuring Eth-Ring

Two paths should be configured to form a ring. In this example, VLAN tag 1 is used as control channel for R-APS signaling in the ring.

PE-1:

```
*A:PE-1>config>eth-ring# info
----------------------------------------------
        path a 1/1/1 raps-tag 1
            eth-cfm
                mep 111 domain 1 association 1
                    ccm-enable
                    control-mep
                    no shutdown
                exit
            exit
            no shutdown
        exit
        path b 1/1/2 raps-tag 1
            eth-cfm
                mep 121 domain 1 association 2
                    ccm-enable
                    control-mep
                    no shutdown
                exit
            exit
            no shutdown
        exit
        no shutdown
----------------------------------------------
*A:PE-1>config>eth-ring#
```

It is mandatory to configure a MEP under the path otherwise this error will be displayed.

```
*A:PE-1>config>eth-ring>path# no shutdown
INFO: ERMGR #1001 Not permitted - must configure eth-cfm MEP first
*A:PE-1>config>eth-ring>path#
```

Note that while MEPs are mandatory, enabling CCMs on the MEPs under the paths as a failure detection mechanism is optional.

PE-2:

In order to define the RPL, node PE-2 has been configured as the RPL owner and path "a" as the RPL end. The link between nodes PE-1 and PE-2 will be the RPL with node PE-2 blocking that link when the ring is fully operational.

```
A:PE-2>config>eth-ring# info
---------------------------------------------
        revert-time 60
        rpl-node owner
        path a 1/1/1 raps-tag 1
            rpl-end
            eth-cfm
                mep 112 domain 1 association 1
                    ccm-enable
                    control-mep
                    no shutdown
                exit
            exit
            no shutdown
        exit
        path b 1/1/2 raps-tag 1
            eth-cfm
                mep 122 domain 1 association 2
                    ccm-enable
                    control-mep
                    no shutdown
                exit
            exit
            no shutdown
        exit
        no shutdown
---------------------------------------------
A:PE-2>config>eth-ring#
```

It is not permitted to configure a path as an RPL end without having configured the node on this ring to be either the RPL *owner* or *nbr* otherwise the following error message is reported.

```
*A:PE-2>config>eth-ring# path a rpl-end
INFO: ERMGR #1001 Not permitted - path-type rpl-end is not consistent with eth-ring 'rpl-
node' type
*A:PE-2>config>eth-ring#
```

PE-3:

```
A:PE-3>config>eth-ring# info
---------------------------------------------
        path a 1/1/1 raps-tag 1
            eth-cfm
                mep 113 domain 1 association 1
                    ccm-enable
                    control-mep
                    no shutdown
                exit
            exit
            no shutdown
        exit
        path b 1/1/2 raps-tag 1
            eth-cfm
```

```
                    mep 123 domain 1 association 2
                        ccm-enable
                        control-mep
                        no shutdown
                    exit
                exit
                no shutdown
            exit
            no shutdown
    ---------------------------------------------
    A:PE-3>config>eth-ring#
```

Until the Ethernet Ring instance is attached to the service (VPLS in this case), the ring operational status is down and the forwarding status of each port is blocked. This prevents operator from creating a loop by mis-configuration. This state can be seen on ring node PE-1 as follows

```
*A:PE-1# show eth-ring 1
===============================================================================
Ethernet Ring 1 Information
===============================================================================
Description       : (Not Specified)
Admin State       : Up                 Oper State       : Down
Node ID           : ea:4b:ff:00:00:00
Guard Time        :     5 deciseconds  RPL Node         : rplNone
Max Revert Time   :  300 seconds       Time to Revert   : N/A
CCM Hold Down Time :    0 centiseconds  CCM Hold Up Time :   20 deciseconds
Compatible Version : 2
APS Tx PDU        : Request State: 0xB
                    Sub-Code     : 0x0
                    Status       : 0x20  ( BPR )
                    Node ID      : ea:4b:ff:00:00:00
Defect Status     :

Sub-Ring Type     : none
-------------------------------------------------------------------------------
Ethernet Ring Path Summary
-------------------------------------------------------------------------------
Path Port      Raps-Tag    Admin/Oper    Type          Fwd State
-------------------------------------------------------------------------------
  a  1/1/1     1           Up/Down       normal        blocked
  b  1/1/2     1           Up/Down       normal        blocked
===============================================================================
*A:PE-1#
```

Step 3. Adding eth-ring SAP to the control channel service.

Path a and b defined in the eth-ring must be added as SAPs into a VPLS service (standard VPLS in this example) using the *eth-ring* parameter. The SAP encapsulation values must match the values of the *raps-tag* configured for the associated path.

G.8032 uses the same raps-tag value on all nodes on the ring, as configured in this example. However, the 7x50 implementation relaxes this constraint by requiring the tag to match only on adjacent nodes.

PE-1:

```
*A:PE-1# configure service vpls 10 customer 1 create
*A:PE-1>config>service>vpls# info
----------------------------------------------
            stp
                shutdown
            exit
            sap 1/1/1:1 eth-ring 1 create
                stp
                    shutdown
                exit
            exit
            sap 1/1/2:1 eth-ring 1 create
                stp
                    shutdown
                exit
            exit
            no shutdown
----------------------------------------------
*A:PE-1>config>service>vpls#
```

PE-2:

```
*A:PE-2# /configure service vpls 10 customer 1 create
*A:PE-2>config>service>vpls# info
----------------------------------------------
            stp
                shutdown
            exit
            sap 1/1/1:1 eth-ring 1 create
                stp
                    shutdown
                exit
            exit
            sap 1/1/2:1 eth-ring 1 create
                stp
                    shutdown
                exit
            exit
            no shutdown
----------------------------------------------
*A:PE-2>config>service>vpls#
```

PE-3:

```
A:PE-3# configure service vpls 10 customer 1 create
A:PE-3>config>service>vpls# info
----------------------------------------------
            stp
                shutdown
            exit
            sap 1/1/1:1 eth-ring 1 create
                stp
                    shutdown
                exit
            exit
            sap 1/1/2:1 eth-ring 1 create
                stp
                    shutdown
                exit
            exit
            no shutdown
----------------------------------------------
A:PE-3>config>service>vpls#
```

Note that you cannot add a normal SAP or SDP in a control channel VPLS, only SAPs with an *eth-ring* parameter can be added. Trying to add a SAP without this parameter into a control channel VPLS will result in the message below being displayed.

```
A:PE-3>config>service>vpls# sap 1/2/1:1 create
MINOR: SVCMGR #1321 Service contains an Ethernet ring control SAP
A:PE-3>config>service>vpls#
```

Now the Eth-Ring is operationally up and the RPL is blocking successfully on ring node PE-2 port 1/1/1, as expected from the RPL owner/end configuration.

An overview of all of the ring(s) can be shown using the following commands, in this case on node PE-2.

First, the ETH ring status is shown.

```
*A:PE-2# show eth-ring status
===============================================================================
Ethernet Ring (Status information)
===============================================================================
Ring   Admin  Oper       Path Information                 MEP Information
ID     State  State  Path          Tag       State    Ctrl-MEP CC-Intvl Defects
-------------------------------------------------------------------------------
1      Up     Up     a - 1/1/1   1           Up       Yes      1        -----
                     b - 1/1/2   1           Up       Yes      1        -----
===============================================================================
Ethernet Tunnel MEP Defect Legend:
R = Rdi, M = MacStatus, C = RemoteCCM, E = ErrorCCM, X = XconCCM
*A:PE-2#
```

The ring and path forwarding states is shown with following command.

```
*A:PE-2# show eth-ring
===============================================================================
Ethernet Rings (summary)
===============================================================================
Ring Int  Admin Oper         Paths Summary                     Path States
ID   ID   State State                                          a      b
-------------------------------------------------------------------------------
1    -    Up    Up   a - 1/1/1   1          b - 1/1/2   1       B      U
===============================================================================
Ethernet Ring Summary Legend:  B - Blocked    U - Unblocked
*A:PE-2#
```

Specific ring information can be shown on each node separately, as follows.

PE-1:

```
*A:PE-1# show eth-ring 1
===============================================================================
Ethernet Ring 1 Information
===============================================================================
Description        : (Not Specified)
Admin State        : Up                Oper State       : Up
Node ID            : ea:4b:ff:00:00:00
Guard Time         :     5 deciseconds  RPL Node        : rplNone
Max Revert Time    :  300 seconds       Time to Revert  : N/A
CCM Hold Down Time :    0 centiseconds  CCM Hold Up Time :   20 deciseconds
Compatible Version : 2
APS Tx PDU         : N/A
Defect Status      :

Sub-Ring Type      : none


-------------------------------------------------------------------------------
Ethernet Ring Path Summary
-------------------------------------------------------------------------------
Path Port     Raps-Tag    Admin/Oper    Type          Fwd State
-------------------------------------------------------------------------------
  a  1/1/1    1                Up/Up      normal        unblocked
  b  1/1/2    1                Up/Up      normal        unblocked
===============================================================================
*A:PE-1#




PE-2:
*A:PE-2# show eth-ring 1
===============================================================================
Ethernet Ring 1 Information
===============================================================================
Description        : (Not Specified)
Admin State        : Up                Oper State       : Up
Node ID            : ea:4c:ff:00:00:00
Guard Time         :     5 deciseconds  RPL Node        : rplOwner
```

```
Max Revert Time   :   60 seconds      Time to Revert  : N/A
CCM Hold Down Time :    0 centiseconds  CCM Hold Up Time :   20 deciseconds
Compatible Version : 2
APS Tx PDU         : Request State: 0x0
                     Sub-Code     : 0x0
                     Status       : 0x80  ( RB )
                     Node ID      : ea:4c:ff:00:00:00
Defect Status      :

Sub-Ring Type      : none
-------------------------------------------------------------------------------
Ethernet Ring Path Summary
-------------------------------------------------------------------------------
Path Port      Raps-Tag    Admin/Oper    Type         Fwd State
-------------------------------------------------------------------------------
  a  1/1/1    1             Up/Up         rplEnd        blocked
  b  1/1/2    1             Up/Up         normal        unblocked
===============================================================================
*A:PE-2#
```

Note that node PE-2 is the RPL owner and that port 1/1/1 is the RPL end. The *revert-time* shows the configured value.

When a revert is pending, the "Time to Revert" will show the number of seconds remaining before the revert occurs, as below.

```
*A:PE-2# show eth-ring 1
===============================================================================
Ethernet Ring 1 Information
===============================================================================
Description        : (Not Specified)
Admin State        : Up                 Oper State       : Up
Node ID            : ea:4c:ff:00:00:00
Guard Time         :    5 deciseconds   RPL Node         : rplOwner
Max Revert Time    :   60 seconds       Time to Revert   :   45 seconds
CCM Hold Down Time :    0 centiseconds  CCM Hold Up Time :   20 deciseconds
Compatible Version : 2
APS Tx PDU         : N/A
Defect Status      :

Sub-Ring Type      : none
-------------------------------------------------------------------------------
Ethernet Ring Path Summary
-------------------------------------------------------------------------------
Path Port      Raps-Tag    Admin/Oper    Type         Fwd State
-------------------------------------------------------------------------------
  a  1/1/1    1             Up/Up         rplEnd        unblocked
  b  1/1/2    1             Up/Up         normal        unblocked
===============================================================================
*A:PE-2#
```

On reversion, the following console message is logged.

```
9 2014/10/03 12:54:06.84 UTC MINOR: ERING #2001 Base eth-ring-1
"Eth-Ring 1 path 0 changed fwd state to blocked"
```

PE-3:

```
*A:PE-3# show eth-ring 1
===============================================================================
Ethernet Ring 1 Information
===============================================================================
Description        : (Not Specified)
Admin State        : Up                 Oper State        : Up
Node ID            : ea:4d:ff:00:00:00
Guard Time         :     5 deciseconds  RPL Node          : rplNone
Max Revert Time    :   300 seconds      Time to Revert    : N/A
CCM Hold Down Time :     0 centiseconds CCM Hold Up Time  :   20 deciseconds
Compatible Version : 2
APS Tx PDU         : N/A
Defect Status      :

Sub-Ring Type      : none
-------------------------------------------------------------------------------
Ethernet Ring Path Summary
-------------------------------------------------------------------------------
Path Port      Raps-Tag       Admin/Oper     Type          Fwd State
-------------------------------------------------------------------------------
  a  1/1/1     1              Up/Up          normal        unblocked
  b  1/1/2     1              Up/Up          normal        unblocked
===============================================================================
*A:PE-3#
```

Finally, the details of an individual path can be shown.

```
*A:PE-2# show eth-ring 1 path b
===============================================================================
Ethernet Ring 1 Path Information
===============================================================================
Description        : (Not Specified)
Port               : 1/1/2              Raps-Tag          : 1
Admin State        : Up                 Oper State        : Up
Path Type          : normal             Fwd State         : unblocked
                                        Fwd State Change  : 10/03/2014 11:56:17
Last Switch Command: noCmd
APS Rx PDU         : Request State: 0x0
                     Sub-Code     : 0x0
                     Status       : 0x00  ( )
                     Node ID      : ea:4d:ff:00:00:00
===============================================================================
*A:PE-2#
```

Step 4. Configuring the user data channel VPLS service

The user data channels are created on a separate VPLS, vpls 100 in the example. Tag 100 and VPLS 100 are used here. The ring data channels must be on the same ports as the corresponding control channels configured above. The access into the data services can use SAPs and/or SDPs.

PE-1:

```
*A:PE-1# configure service vpls 100
*A:PE-1>config>service>vpls# info
----------------------------------------------
            stp
                shutdown
            exit
            sap 1/1/1:100 eth-ring 1 create
                stp
                    shutdown
                exit
            exit
            sap 1/1/2:100 eth-ring 1 create
                stp
                    shutdown
                exit
            exit
            sap 1/2/1:100 create
                stp
                    shutdown
                exit
            exit
            no shutdown
----------------------------------------------
*A:PE-1>config>service>vpls#
```

PE-2:

```
*A:PE-2# configure service vpls 100
*A:PE-2>config>service>vpls# info
----------------------------------------------
            stp
                shutdown
            exit
            sap 1/1/1:100 eth-ring 1 create
                stp
                    shutdown
                exit
            exit
            sap 1/1/2:100 eth-ring 1 create
                stp
                    shutdown
                exit
            exit
            sap 1/2/1:100 create
                stp
                    shutdown
```

```
                    exit
            exit
            no shutdown
---------------------------------------------
*A:PE-2>config>service>vpls#
```

PE-3:

```
*A:PE-3# configure service vpls 100
*A:PE-3>config>service>vpls# info
---------------------------------------------
            stp
                shutdown
            exit
            sap 1/1/1:100 eth-ring 1 create
                stp
                    shutdown
                exit
            exit
            sap 1/1/2:100 eth-ring 1 create
                stp
                    shutdown
                exit
            exit
            sap 1/2/1:100 create
                stp
                    shutdown
                exit
            exit
            no shutdown
---------------------------------------------
*A:PE-3>config>service>vpls#
```

All of the SAPs which are configured to use ETH rings can be shown, using PE-1 as an example.

```
*A:PE-1# show service sap-using eth-ring
===============================================================================
Service Access Points (Ethernet Ring)
===============================================================================
SapId           SvcId          Eth-Ring Path Admin Oper  Blocked Control/
                                              State State         Data
-------------------------------------------------------------------------------
1/1/1:1         10             1        a    Up    Up    No      Ctrl
1/1/2:1         10             1        b    Up    Up    No      Ctrl
1/1/1:100       100            1        a    Up    Up    No      Data
1/1/2:100       100            1        b    Up    Up    No      Data
-------------------------------------------------------------------------------
Number of SAPs : 4
===============================================================================
*A:PE-1#
```

To see an example of the console messages on a ring failure, when the unblocked port (1/1/2) on node PE-2 is shutdown, the following messages are displayed.

```
*A:PE-2# configure port 1/1/2 shutdown

10 2014/10/03 12:56:18.03 UTC WARNING: SNMP #2004 Base 1/1/2
"Interface 1/1/2 is not operational"

11 2014/10/03 12:56:18.03 UTC MINOR: ERING #2001 Base eth-ring-1
"Eth-Ring 1 path 1 changed fwd state to blocked"

12 2014/10/03 12:56:18.03 UTC MINOR: ERING #2001 Base eth-ring-1
"Eth-Ring 1 path 0 changed fwd state to unblocked"

13 2014/10/03 12:56:18.04 UTC MAJOR: SVCMGR #2210 Base
"Processing of an access port state change event is finished and the status of a
ll affected SAPs on port 1/1/2 has been updated."

14 2014/10/03 12:56:21.85 UTC MINOR: ETH_CFM #2001 Base
"MEP 1/2/122 highest defect is now defRemoteCCM"
```

For troubleshooting, the **tools dump eth-ring** *<ring-index>* command displays path information, the internal state of the control protocol, related statistics information and up to the last 16 protocol events (including messages sent and received, and the expiration of timers). An associated parameter *clear* exists, clearing the event information in this output when the command is entered. The following is an example of the output on node PE-2 with port 1/1/2 active.

```
*A:PE-2# tools dump eth-ring 1

ringId 1 (Up/Up): numPaths 2 nodeId ea:4c:ff:00:00:00
 SubRing: none (interconnect ring 0, propagateTc  No), Cnt 0
  path-a, port 1/1/1 (Up), tag 1.0(Up) status (Up/Up/Blk)
      cc (Dn/Up): Cnt 5/5 tm 000 17:43:30.030/000 17:46:05.690
      state: Cnt 23 B/F 000 17:54:59.030/000 17:52:31.220, flag: 0x0
  path-b, port 1/1/2 (Up), tag 1.0(Up) status (Up/Up/Fwd)
      cc (Dn/Up): Cnt 5/5 tm 000 17:52:35.040/000 17:53:56.900
      state: Cnt 8 B/F 000 17:52:31.220/000 17:53:59.890, flag: 0x0
  FsmState=  IDLE, Rpl = Owner, revert = 60 s, guard = 5 ds
    Defects =
    Running Timers = PduReTx
    lastTxPdu = 0x0080 Nr(RB )
    path-a Rpl, RxId(I)= ea:4d:ff:00:00:00, rx= v1-0x0020 Nr, cmd= None
    path-b Normal, RxId(I)= ea:4d:ff:00:00:00, rx= v1-0x0020 Nr, cmd= None
  DebugInfo:  aPathSts 7, bPathSts 7, pm (set/clr) 0/0, txFlush 0
    RxRaps: ok 67 nok 0 self 3447, TmrExp - wtr 11(1), grd 7, wtb 0
    Flush: cnt 31 (16/15/0) tm 000 17:54:59.030-000 17:54:59.030 Out/Ack 0/1
    RxRawRaps: aPath 12397 bPath 12544 vPath 0
    Now: 000 17:55:40.030 , softReset: No - noTx 0

  Seq Event  RxInfo(Path: NodeId-Bytes)
             state:TxInfo (Bytes)            Dir  pA  pB        Time
  === ===== ============================  ===== === === ================
  010    aUp
             PEND-G: 0x0000  Nr            Tx--> Blk Fwd 000 17:46:08.230
  011    pdu B: ea:4d:ff:00:00:00-0x0000 Nr
```

```
                PEND  : 0x0000  Nr              Rx<-- Blk Fwd 000 17:46:12.890
     012   pdu
                PEND  :                         ----- Fwd Fwd 000 17:46:12.890
     013   pdu A: ea:4d:ff:00:00:00-0x0000 Nr
                PEND  :                         Rx<-- Fwd Fwd 000 17:46:12.890
     014   xWtr
                IDLE  : 0x0080  Nr(RB )         TxF-> Blk Fwd 000 17:47:12.030
     015   pdu B: ea:4d:ff:00:00:00-0xb000 Sf
                IDLE  : 0x0080  Nr(RB )         RxF<- Blk Fwd 000 17:49:20.650
     016   pdu
                PROT  :                         ----- Fwd Fwd 000 17:49:20.650
     017   pdu B: ea:4d:ff:00:00:00-0x0000 Nr
                PROT  :                         Rx<-- Fwd Fwd 000 17:49:20.690
     018   pdu
                PEND  :                         ----- Fwd Fwd 000 17:49:20.690
     019   pdu A: ea:4d:ff:00:00:00-0x0000 Nr
                PEND  :                         Rx<-- Fwd Fwd 000 17:49:20.690
     000   xWtr
                IDLE  : 0x0080  Nr(RB )         TxF-> Blk Fwd 000 17:50:20.030
     001   bDn
                PROT  : 0xb020  Sf              TxF-> Fwd Blk 000 17:52:31.220
     002   pdu A: ea:4d:ff:00:00:00-0xb020 Sf
                PROT  : 0xb020  Sf              RxF<- Fwd Blk 000 17:52:34.900
     003   pdu B: ea:4d:ff:00:00:00-0x0020 Nr
                PROT  : 0xb020  Sf              Rx<-- Fwd Blk 000 17:53:58.090
     004   pdu A: ea:4d:ff:00:00:00-0x0020 Nr
                PROT  : 0xb020  Sf              Rx<-- Fwd Blk 000 17:53:58.090
     005   bUp
                PEND-G: 0x0020  Nr              Tx--> Fwd Blk 000 17:53:58.930
     006   pdu B: ea:4d:ff:00:00:00-0x0020 Nr
                PEND  : 0x0020  Nr              Rx<-- Fwd Blk 000 17:53:59.890
     007   pdu
                PEND  :                         ----- Fwd Fwd 000 17:53:59.890
     008   pdu A: ea:4d:ff:00:00:00-0x0020 Nr
                PEND  :                         Rx<-- Fwd Fwd 000 17:53:59.890
     009   xWtr
                IDLE  : 0x0080  Nr(RB )         TxF-> Blk Fwd 000 17:54:59.030


     *A:PE-2#
```

Conclusion

Ethernet Ring APS provides optimal solution for designing native Ethernet services with ring topology. This protocol provides simple configuration, operation and guaranteed fast protection time. 7x50 also has a flexible encapsulation that allows dot1Q, qinq or PBB for the ring traffic. It could be utilized for various services such as mobile backhaul, business VPN access, aggregation and core.