Allied Telesis

AlliedWare Plus™ OS

How To | Configure EPSR (Ethernet Protection Switching Ring) to Protect a Ring from Loops

Introduction

Putting a ring of Ethernet switches at the core of a network is a simple way to increase the network's resilience—such a network is no longer susceptible to a single point of failure. However, the ring must be protected from Layer 2 loops. Traditionally, STP-based technologies are used to protect rings, but they are relatively slow to recover from link failure. This can create problems for applications that have strict loss requirements, such as voice and video traffic, where the speed of recovery is highly significant.

This How To Note describes a fast alternative to STP: Ethernet Protection Switching Ring (EPSR). EPSR enables rings to recover rapidly from link or node failures—within as little as 50ms, depending on port type and configuration. This is much faster than STP at 30 seconds or even RSTP at 1 to 3 seconds.

What information will you find in this document?

This How To Note begins by describing EPSR in the following sections:

- "How EPSR Works" on page 3
- "Establishing a Ring" on page 4
- "Detecting a Fault" on page 5
- "Recovering from a Fault" on page 5
- "Restoring Normal Operation" on page 7

Next it gives step-by-step configuration details and examples in the following sections:

- "How To Configure EPSR" on page 8
- "Example 1: A Basic Ring" on page 10
- "Example 2: A Double Ring" on page 12

- "Example 3: EPSR and RSTP" on page 16
- "Example 4: EPSR with Nested VLANs" on page 19
- "Example 5: EPSR with an iMAP" on page 25
- "Example 5: EPSR with an iMAP" on page 25

Next, it discusses important implementation details in the following sections:

- "Classifiers and Hardware Filters" on page 28
- "Ports and Recovery Times" on page 29
- "IGMP Snooping and Recovery Times" on page 29
- "Health Message Priority" on page 30

Finally, it ends with troubleshooting information in the following sections:

- "EPSR State and Settings" on page 31
- "SNMP Traps" on page 32
- "Counters" on page 33
- "Debugging" on page 34

Which products and software versions does it apply to?

This How To Note applies to the following Allied Telesis switches, running the AlliedWare Plus software version 5.2.1 or later:

- SwitchBlade x908
- x900 series
- x600 series

To see which x900 series switch models run AlliedWare Plus, see the AlliedWare Plus Operating System Datasheet.

EPSR is also available on the following Layer 3 switches running the AlliedWare OS:

- AT-8948, x900-48FE, x900-48FE-N, AT-9924T, AT-9924SP, and AT-9924T/4SP switches, running software version 2.8.1 or later
- AT-9924Ts, x900-24XT, and x900-24XT-N switches running software version 3.1.1 or later

For AlliedWare OS configurations, see the AlliedWare OS How To Note *How To Configure EPSR (Ethernet Protection Switching Ring) to Protect a Ring from Loops*. This How To Note is available from www.alliedtelesis.com/resources/literature/howto.aspx.

The implementation on the above switches is also compatible with EPSR on Allied Telesis' Multiservice Access Platforms (iMAPs).

How EPSR Works

EPSR operates on physical rings of switches (note, not on meshed networks). When all nodes and links in the ring are up, EPSR prevents a loop by blocking data transmission across one port. When a node or link fails, EPSR detects the failure rapidly and responds by unblocking the blocked port so that data can flow around the ring.

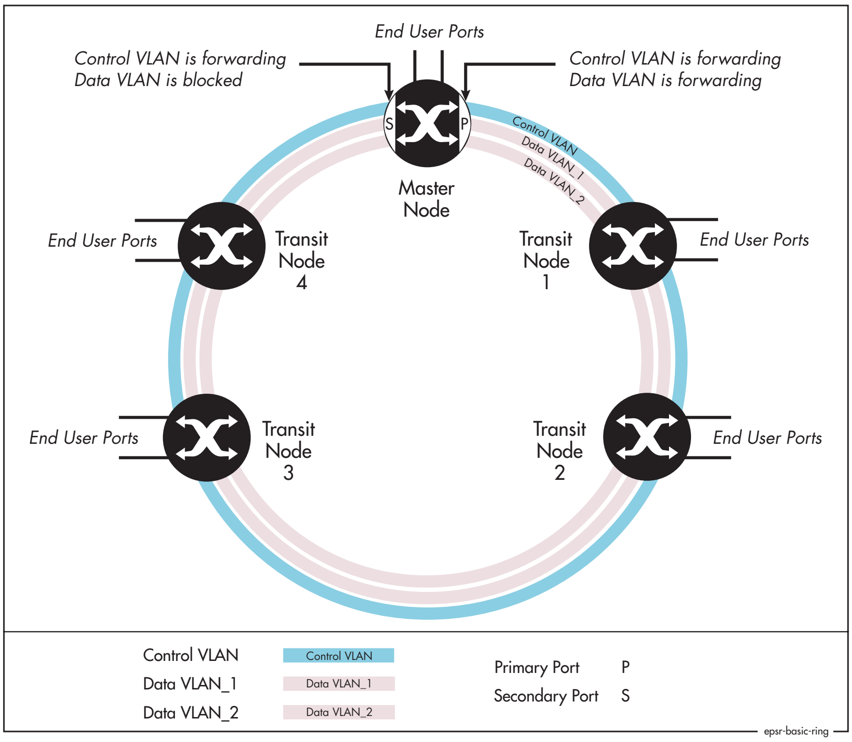
In EPSR, each ring of switches forms an **EPSR domain**. One of the domain's switches is the **master node** and the others are **transit nodes**. Each node connects to the ring via two ports.

One or more **data VLANs** sends data around the ring, and a **control VLAN** sends EPSR messages. A physical ring can have more than one EPSR domain, but each domain operates as a separate logical group of VLANs and has its own control VLAN and master node.

On the master node, one port is the **primary port** and the other is the **secondary port**. When all the nodes in the ring are up, EPSR prevents loops by blocking the data VLAN on the secondary port.

The master node does not need to block any port on the control VLAN because loops never form on the control VLAN. This is because the master node never forwards any EPSR messages that it receives.

The following diagram shows a basic ring with all the switches in the ring up.



EPSR Components

EPSR domain:

A protection scheme for an Ethernet ring that consists of one or more data VLANs and a control VLAN.

Master node:

The controlling node for a domain, responsible for polling the ring state, collecting error messages, and controlling the flow of traffic in the domain.

Transit node:

Other nodes in the domain.

Ring port:

A port that connects the node to the ring. On the master node, each ring port is either the primary port or the secondary port. On transit nodes, ring ports do not have roles.

Primary port:

A ring port on the master node. This port determines the direction of the traffic flow, and is always operational.

Secondary port:

A second ring port on the master node. This port remains active, but blocks all protected VLANs from operating unless the ring fails. Similar to the blocking port in an STP/RSTP instance.

Control VLAN:

The VLAN over which all control messages are sent and received. EPSR never blocks this VLAN.

Data VLAN

A VLAN that needs to be protected from loops. Each EPSR domain has one or more data VLANs.

Establishing a Ring

Once you have configured EPSR on the switches, the following steps complete the EPSR ring:

1. The master node creates an EPSR **Health** message and sends it out the primary port. This increments the master node's **Transmit: Health** counter in the **show epsr count** command.
2. The first transit node receives the Health message on one of its two ring ports and, using a hardware filter, sends the message out its other ring port.

   Note that transit nodes never generate Health messages, only receive them and forward them with their switching hardware. This does not increment the transit node's Transmit: Health counter. However, it does increment the Transmit counter in the **show switch port** command.

   The hardware filter also copies the Health message to the CPU. This increments the transit node's **Receive: Health** counter. The CPU processes this message as required by the state machines, but does not send the message anywhere because the switching hardware has already done this.
3. The Health message continues around the rest of the transit nodes, being copied to the CPU and forwarded in the switching hardware.
4. The master node eventually receives the Health message on its secondary port. The master node's hardware filter copies the packet to the CPU (which increments the master node's Receive: Health counter). Because the master received the Health message on its secondary port, it knows that all links and nodes in the ring are up.

   When the master node receives the Health message back on its secondary port, it resets the Failover timer. If the Failover timer expires before the master node receives the Health message back, it concludes that the ring must be broken.

   Note that the master node does not send that particular Health message out again. If it did, the packet would be continuously flooded around the ring. Instead, the master node generates a new Health message when the Hello timer expires.

Detecting a Fault

EPSR uses a fault detection scheme that alerts the ring when a break occurs, instead of using a spanning tree-like calculation to determine the best path. The ring then automatically heals itself by sending traffic over a protected reverse path.

EPSR uses the following two methods to detect when a transit node or a link goes down:

- Master node polling fault detection

  To check the condition of the ring, the master node regularly sends Health messages out its primary port, as described in "Establishing a Ring" on page 4. If all links and nodes in the ring are up, the messages arrive back at the master node on its secondary port.

  This can be a relatively slow detection method, because it depends on how often the node sends Health messages.

  Note that the master node only ever sends Health messages out its primary port. If its primary port goes down, it does not send Health messages.

- Transit node unsolicited fault detection

  To speed up fault detection, EPSR transit nodes directly communicate when one of their interfaces goes down. When a transit node detects a fault at one of its interfaces, it immediately sends a Link-Down message over the link that remains up. This notifies the master node that the ring is broken and causes it to respond immediately.

Recovering from a Fault

Fault in a link or a transit node

When the master node detects an outage somewhere in the ring, using either detection method, it restores traffic flow by:

1. declaring the ring to be in a **Failed** state
2. unblocking its secondary port, which enables data VLAN traffic to pass between its primary and secondary ports
3. flushing its own forwarding database (FDB) for the two ring ports

Master Node States

Complete:

The state when there are no link or node failures on the ring.

Failed:

The state when there is a link or node failure on the ring. This state indicates that the master node received a Link-Down message or that the failover timer expired before the master node's secondary port received a Health message.

Transit Node States

Idle:

The state when EPSR is first configured, before the master node determines that all links in the ring are up. In this state, both ports on the node are blocked for the data VLAN. From this state, the node can move to Links Up or Links Down.

Links Up:

The state when both the node's ring ports are up and forwarding. From this state, the node can move to Links Down.

Links Down:

The state when one or both of the node's ring ports are down. From this state, the node can move to Pre-forwarding

Pre-forwarding:

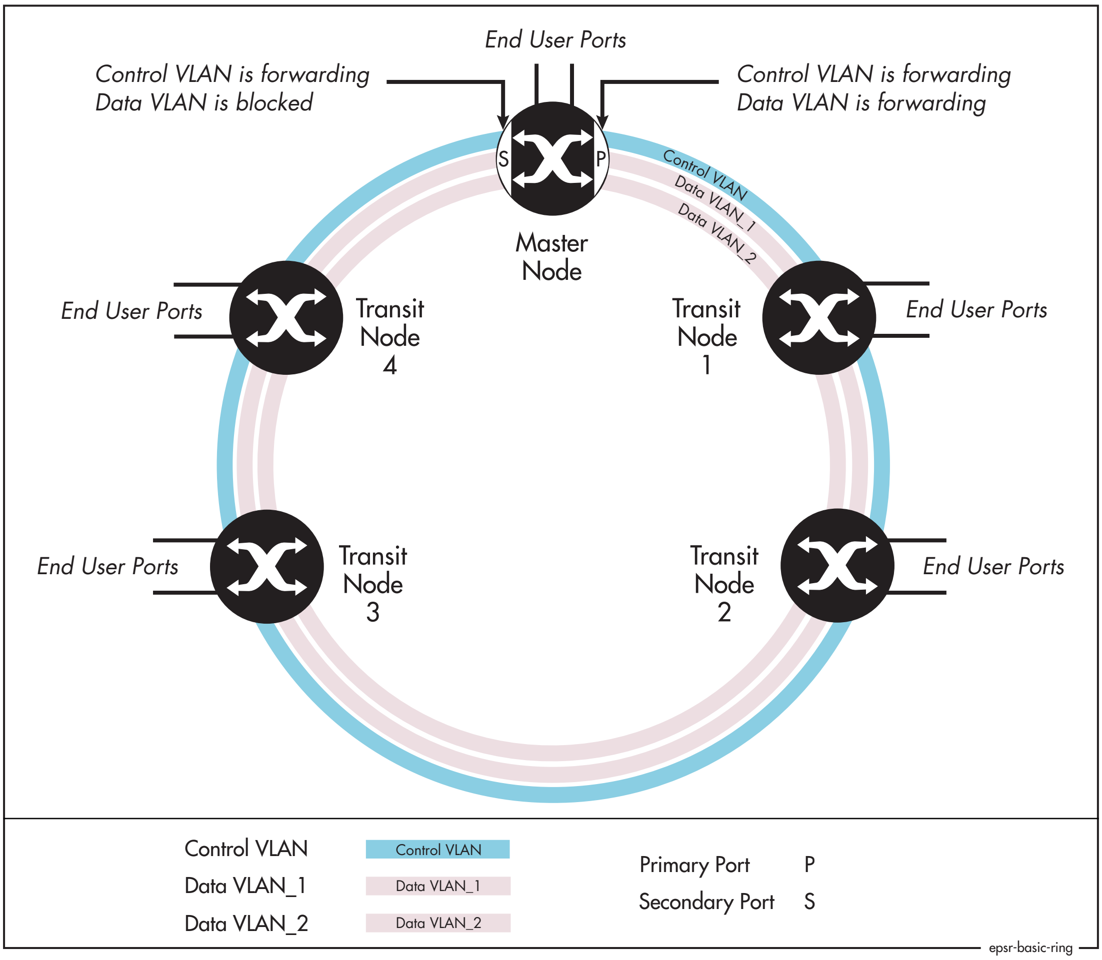
The state when both ring ports are up, but one has only just come up and is still blocked to prevent loops. From this state, the transit node can move to Links Up if the master node blocks its secondary port, or to Links Down if another port goes down.

4. sending an EPSR **Ring-Down-Flush-FDB** control message to all the transit nodes, via both its primary and secondary ports

   The transit nodes respond to the Ring-Down-Flush-FDB message by flushing their forwarding databases for each of their ring ports. As the data starts to flow in the ring's new configuration, the nodes (master and transit) re-learn their layer 2 addresses. During this period, the master node continues to send Health messages over the control VLAN. This situation continues until the faulty link or node is repaired.

For a multidomain ring, this process occurs separately for each domain within the ring.

The following figure shows the flow of control frames when a link breaks.



Fault in the master node

If the master node goes down, the transit nodes simply continue forwarding traffic around the ring—their operation does not change.

The only observable effects on the transit nodes are that:

- They stop receiving Health messages and other messages from the master node.
- The transit nodes connected to the master node experience a broken link, so they send Link-Down messages. If the master node is down these messages are simply dropped.

Neither of these symptoms affect how the transit nodes forward traffic.

Once the master node recovers, it continues its function as the master node.

Restoring Normal Operation

Master Node

Once the fault has been fixed, the master node's Health messages traverse the whole ring and arrive at the master node's secondary port. The master node then restores normal conditions by:

1. declaring the ring to be in a state of **Complete**
2. blocking its secondary port for data VLAN traffic (but not for the control VLAN)
3. flushing its forwarding database for its two ring ports
4. sending a Ring-Up-Flush-FDB message from its primary port, to all transit nodes.

Transit Nodes with One Port Down

As soon as the fault has been fixed, the transit nodes on each side of the (previously) faulty link section detect that link connectivity has returned. They change their ring port state from Links Down to Pre-Forwarding, and wait for the master node to send a Ring-Up-Flush-FDB control message.

Once these transit nodes receive the Ring-Up-Flush-FDB message, they:

- flush the forwarding databases for both their ring ports
- change the state of their ports from blocking to forwarding for the data VLAN, which allows data to flow through their previously-blocked ring ports

The transit nodes do not start forwarding traffic on the previously-down ports until after they receive the Ring-Up-Flush-FDB message. This makes sure the previously-down transit node ports stay blocked until after the master node blocks its secondary port. Otherwise, the ring could form a loop because it had no blocked ports.

Transit Nodes with Both Ports Down

The Allied Telesis implementation includes an extra feature to improve handling of double link failures. If both ports on a transit node are down and one port comes up, the node:

1. puts the port immediately into the forwarding state and starts forwarding data out that port. It does not need to wait, because the node knows there is no loop in the ring—because the other ring port on the node is down
2. remains in the Links Down state
3. starts a DoubleFailRecovery timer with a timeout of four seconds
4. waits for the timer to expire. At that time, if one port is still up and one is still down, the transit node sends a Ring-Up-Flush-FDB message out the port that is up. This message is usually called a "Fake Ring Up message".

Sending this message allows any ports on other transit nodes that are blocking or in the Pre-forwarding state to move to forwarding traffic in the Links Up state. The timer delay lets the device at the other end of the link that came up configure its port appropriately, so that it is ready to receive the transmitted message.

Note that the master node would not send a Ring-Up-Flush-FDB message in these circumstances, because the ring is not in a state of Complete. The master node's secondary port remains unblocked.

How To Configure EPSR

This section first outlines, step-by-step, how to configure EPSR. Then it discusses changing the settings for the control VLAN, if you need to do this after initial configuration.

Configuring EPSR

1. Connect your switches into a ring

EPSR does not in itself limit the number of nodes that can exist on any given ring. Each switch can participate in up to 16 rings.

If you already have a ring in a live network, disconnect the cable between any two of the nodes before you start configuring EPSR, to prevent a loop.

2. On each switch, configure EPSR

On each switch, perform the following configuration steps. Configuration of the master node and each transit node is very similar.

i. Configure the control and data VLANs

This step creates the control and data VLANs for EPSR.

Enter global configuration mode and enter the following commands:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan <control-vid> name <control-vlan-name>
awplus(config-vlan)#vlan <data-vid> name <data-vlan-name>
```

ii. Configure the switch ports

This step sets the rings ports to VLAN trunk mode and adds the control and data VLANs.

Enter global configuration mode and enter the following commands:

```
awplus(config)#interface <port-numbers>
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add
  <control-vid,data-vid>
awplus(config-if)#switchport trunk native vlan none
```

Note that the final command removes the native VLAN (vlan1) from the ring ports. If you leave all the ring ports in the native VLAN, they will create a loop, unless vlan1 is part of the EPSR domain. To avoid loops, you need to do one of the following:

- make vlan1 a data VLAN, or
- remove the ring ports from vlan1, or
- remove at least one of the ring ports from vlan1 on at least one of the switches. We do not recommend this option, because the action you have taken is less obvious when maintaining the network later.

In this How To Note, we remove the ring ports from the native VLAN (vlan1).

iii. Configure the EPSR domain

This step creates the domain, specifying whether the switch is the master node or a transit node. It also specifies which VLAN is the control VLAN, and on the master node which port is the primary port.

Enter global configuration mode and enter the following commands:

On the master node:

```
awplus(config)#epsr configuration

awplus(config-epsr)#epsr <name> mode master
  controlvlan <control-vid> primaryport <port-numbers>

awplus(config-epsr)#epsr <name> datavlan <data-vid>
```

On each transit node:

```
awplus(config)#epsr configuration

awplus(config-epsr)#epsr <name> mode transit controlvlan
  <control-vid>

awplus(config-epsr)#epsr <name> datavlan <data-vid>
```

iv. Enable EPSR

This step enables the domain on each switch.

Enter global configuration mode and enter the following commands:

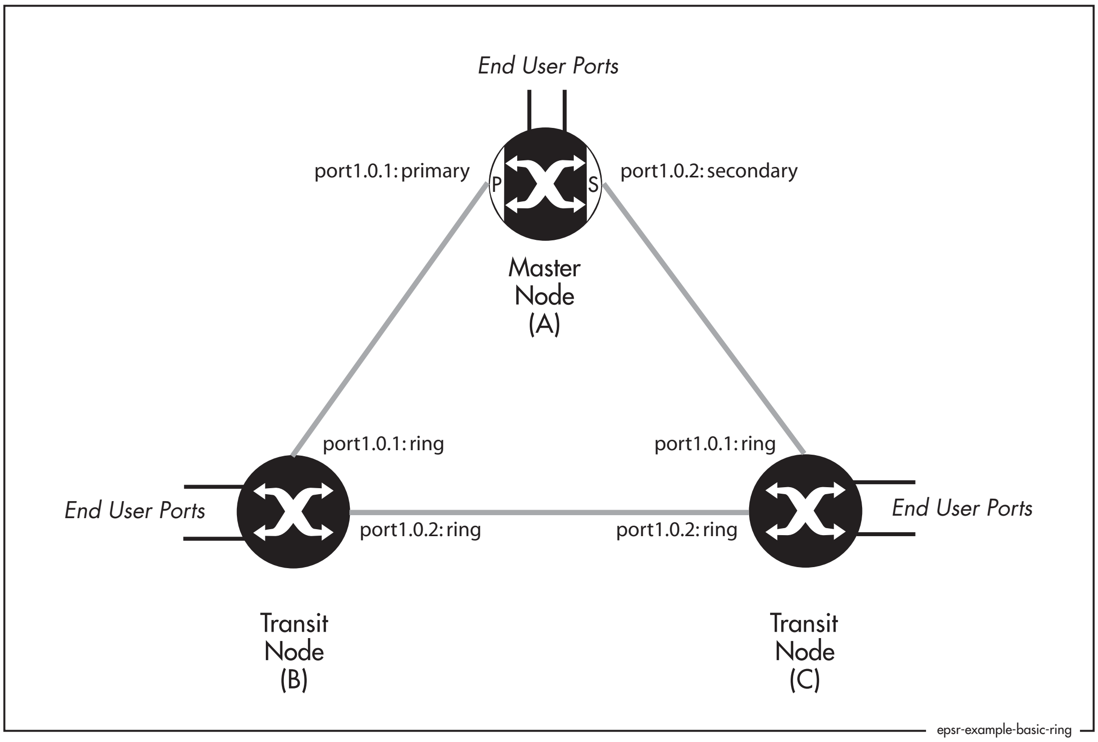
```
awplus(config-epsr)#epsr <name> state enabled
```

3. Configure other ports and protocols as required

On each switch, configure the other ports and protocols that are required for your network.

Example 1: A Basic Ring

This example builds a simple 3-switch ring with one data VLAN, as shown in the following diagram. Control packets are transmitted around the ring on vlan 1000 and data packets on vlan 2.



Configure the Master Node (A)

1. Configure the control and data VLANs

Enter global configuration mode and enter the following commands:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 1000 name epsr-control
awplus(config-vlan)#vlan 2 name data
```

2. Configure the switch ports

```
awplus(config-vlan)#interface port1.0.1-port1.0.2
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 1000,2
awplus(config-if)#switchport trunk native vlan none
```

3. Configure the EPSR domain

Create the domain, specifying that this switch is the master node. Also specify which VLAN is the control VLAN and which port is the primary port. In this example the EPSR domain is called awplus.

```
awplus(config-if)#epsr configuration

awplus(config-epsr)#epsr awplus mode master controlvlan 1000
   primaryport port1.0.1

awplus(config-epsr)#epsr awplus datavlan 2
```

4. Enable EPSR

```
awplus(config-epsr)#epsr awplus state enabled
```

Configure the Transit Nodes (B and C)

Each of the transit nodes has the same EPSR configuration in this example.

1. Configure the control and data VLAN

Enter global configuration mode and enter the following commands:

```
awplus(config)#vlan database

awplus(config-vlan)#vlan 1000 name epsr-control

awplus(config-vlan)#vlan 2 name data
```

2. Configure the switch ports

```
awplus(config-vlan)#interface port1.0.1-port1.0.2

awplus(config-if)#switchport mode trunk

awplus(config-if)#switchport trunk allowed vlan add 1000,2

awplus(config-if)#switchport trunk native vlan none
```

3. Configure the EPSR domain

```
awplus(config-if)#epsr configuration

awplus(config-epsr)#epsr awplus mode transit controlvlan 1000

awplus(config-epsr)#epsr awplus datavlan 2
```

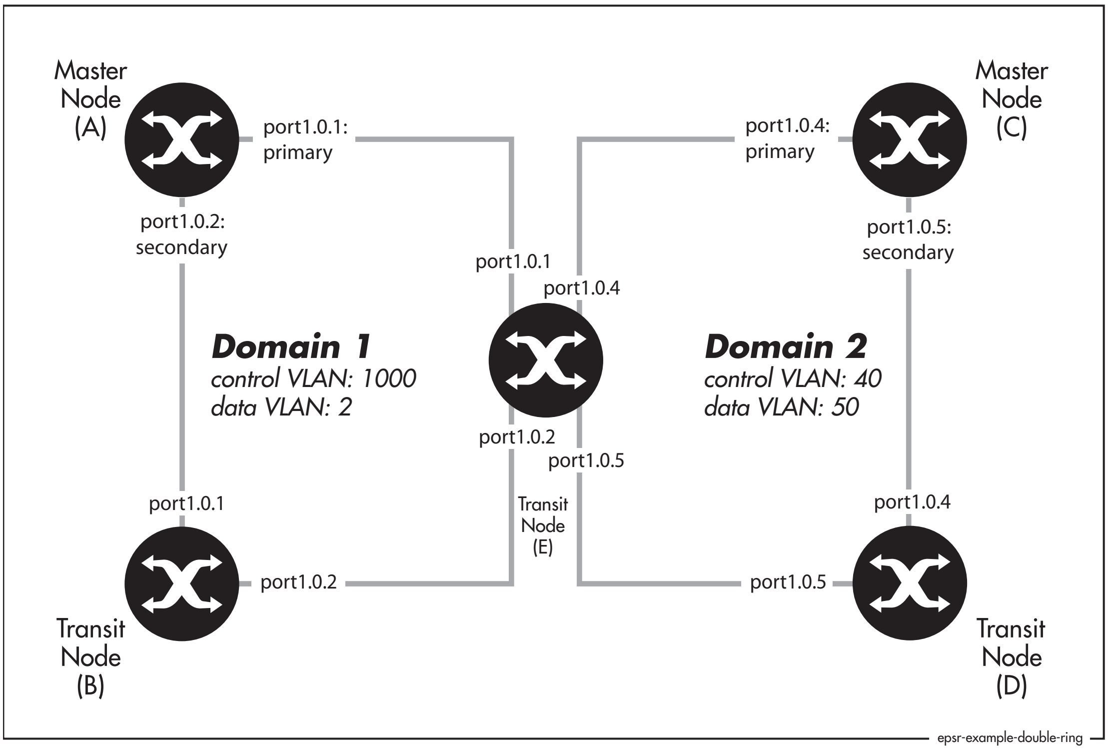
4. Enable EPSR

The two ring ports must belong to both the control VLAN and all data VLANs.

```
awplus(config-epsr)#epsr awplus state enabled
```

Example 2: A Double Ring

This example adds to the previous ring by making two domains, as shown in the following diagram.



1. Configure the master node (switch A) for domain 1

The master node for domain 1 is the same as in the previous example (except that the domain has been renamed).

Enter global configuration mode and enter the following commands:

Configure the control and data VLANs:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 1000 name epsr-control
awplus(config-vlan)#vlan 2 name data
```

Configure the switch ports:

```
awplus(config-vlan)#interface port1.0.1-port1.0.2
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 1000,2
awplus(config-if)#switchport trunk native vlan none
```

Configure the EPSR domain. This device is an EPSR master node:

```
awplus(config-if)#epsr configuration
awplus(config-epsr)#epsr domain1 mode master controlvlan 1000
   primaryport port1.0.1
awplus(config-epsr)#epsr domain1 datavlan 2
```

Enable EPSR:

```
awplus(config-epsr)#epsr domain1 state enabled
awplus(config-epsr)#end
```

2. Configure the transit node (switch B) that belongs just to domain 1

This transit node is the same as in the previous example (except that the domain has been renamed).

Enter global configuration mode and enter the following commands:

Configure the data and control VLANs:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 1000 name epsr-control
awplus(config-vlan)#vlan 2 name data
```

Configure the switch ports:

```
awplus(config-vlan)#interface port1.0.1-port1.0.2
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 1000,2
awplus(config-if)#switchport trunk native vlan none
```

Configure the EPSR domain. This device is a transit node:

```
awplus(config-if)#epsr configuration
awplus(config-epsr)#epsr domain1 mode transit controlvlan 1000
awplus(config-epsr)#epsr domain1 datavlan 2
```

Enable EPSR:

```
awplus(config-epsr)#epsr domain1 state enabled
awplus(config-epsr)#end
```

3. Configure the master node (switch C) for domain 2

Enter global configuration mode and enter the following commands:

```
awplus(config-epsr)#vlan database
awplus(config-vlan)#vlan 40 name epsr-control
awplus(config-vlan)#vlan 50 name data
awplus(config-vlan)#interface port1.0.4-port1.0.5
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 50,40
awplus(config-if)#switchport trunk native vlan none
awplus(config-if)#epsr configuration
awplus(config-epsr)#epsr domain2 mode master controlvlan 40
   primaryport port1.0.4
awplus(config-epsr)#epsr domain2 datavlan 50
awplus(config-epsr)#epsr domain2 state enabled
awplus(config-epsr)#end
```

4. Configure the transit node (switch D) that belongs just to domain 2

Enter global configuration mode and enter the following commands:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 40 name epsr-control
awplus(config-vlan)#vlan 50 name data
awplus(config-vlan)#interface port1.0.4-port1.0.5
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 40,50
awplus(config-if)#switchport trunk native vlan none
awplus(config-if)#epsr configuration
awplus(config-epsr)#epsr domain2 mode transit controlvlan 40
awplus(config-epsr)#epsr domain2 datavlan 50
awplus(config-epsr)#epsr domain2 state enabled
awplus(config-epsr)#end
```

5. Configure the transit node (switch E) that belongs to both domains

Two separate EPSR domains are configured on this device.

Enter global configuration mode and enter the following commands:

Configure the data and control VLANs for domain 1:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 1000 name epsr-control
awplus(config-vlan)#vlan 2 name data
```

Configure the data and control VLANs for domain 2:

```
awplus(config-vlan)#vlan 40 name epsr-control
awplus(config-vlan)#vlan 50 name data
```

Configure the switch ports for domain 1:

```
awplus(config-vlan)#interface port1.0.1-port1.0.2
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 1000,2
awplus(config-if)#switchport trunk native vlan none
```

Configure the switch ports for domain 2:

```
awplus(config-if)#interface port1.0.4-port1.0.5
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 40,50
awplus(config-if)#switchport trunk native vlan none
```

Configure EPSR for domain 1. This device is a transit node:

```
awplus(config-if)#epsr configuration
awplus(config-epsr)#epsr domain1 mode transit controlvlan 1000
awplus(config-epsr)#epsr domain1 datavlan 2
```

Configure EPSR for domain 2. This device is a transit node:

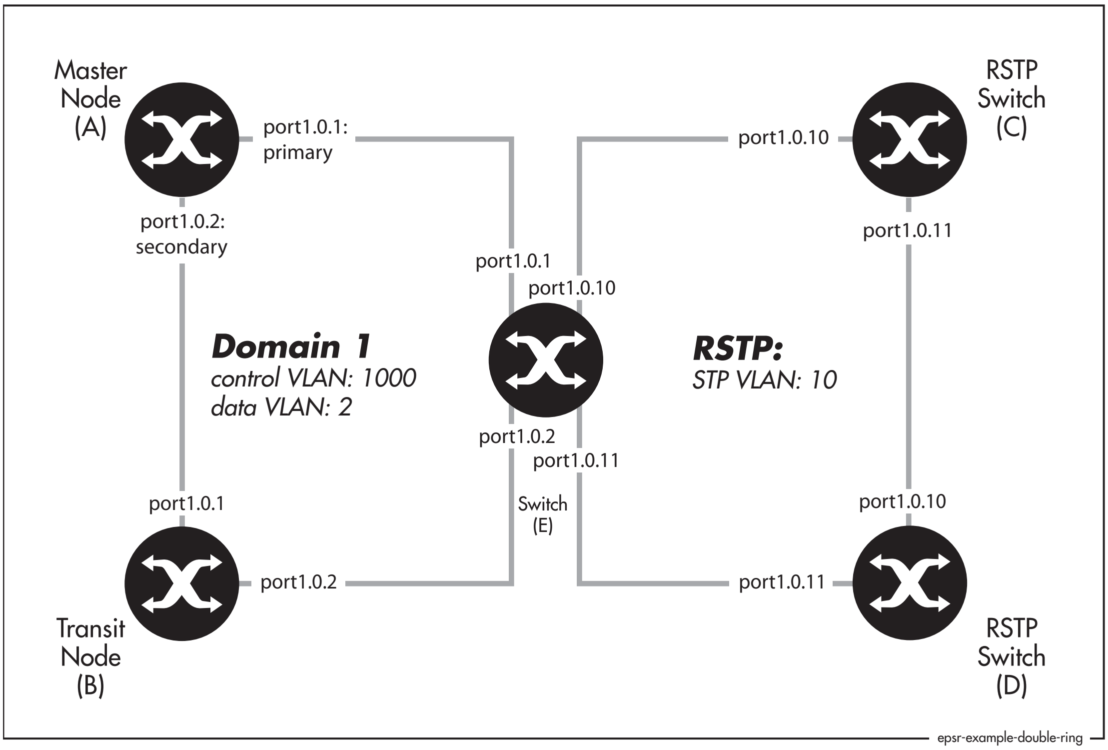
```
awplus(config-epsr)#epsr domain2 mode transit controlvlan 40
awplus(config-epsr)#epsr domain2 datavlan 50
```

Enable EPSR for both domains:

```
awplus(config-epsr)#epsr domain1 state enabled
awplus(config-epsr)#epsr domain2 state enabled
awplus(config-epsr)#end
```

Example 3: EPSR and RSTP

This example shows how to configure both EPSR and RSTP in the same network. It is possible to configure both protocols on a single device. However, it is not possible to run both EPSR and RSTP on the same ports. RSTP is automatically disabled on a port when it is added to an EPSR VLAN.



1. Configure the master node (switch A) for the EPSR domain

The master node is the same as in the previous example.

Enter global configuration mode and enter the following commands:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 1000 name epsr-control
awplus(config-vlan)#vlan 2 name data
awplus(config-vlan)#interface port1.0.1-port1.0.2
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 1000,2
awplus(config-if)#switchport trunk native vlan none
awplus(config-if)#epsr configuration
awplus(config-epsr)#epsr domain1 mode master controlvlan 1000
   primaryport port1.0.1
awplus(config-epsr)#epsr domain1 datavlan 2
awplus(config-epsr)#epsr domain1 state enabled
awplus(config-epsr)#end
```

2. Configure the transit node switch (B) that belongs just to the EPSR domain

This transit node (B) is the same as in the previous example.

Enter global configuration mode and enter the following commands:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 1000 name epsr-control
awplus(config-vlan)#vlan 2 name data
awplus(config-vlan)#interface port1.0.1-port1.0.2
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 1000,2
awplus(config-if)#switchport trunk native vlan none
awplus(config-if)#epsr configuration
awplus(config-epsr)#epsr domain1 mode transit controlvlan 1000
awplus(config-epsr)#epsr domain1 datavlan 2
awplus(config-epsr)#epsr domain1 state enabled
awplus(config-epsr)#end
```

3. Configure the switches that belong to the RSTP instance (switches C and D)

Switches C and D have the same configuration in this example.

Enter global configuration mode and enter the following commands:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 10 name rstp-domain
awplus(config-vlan)#interface port1.0.10-1.0.11
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 10
awplus(config-if)#end
```

Note that RSTP is enabled by default on AlliedWare Plus switches.

4. Configure switch E for EPSR and RSTP

Enter global configuration mode and enter the following commands:

Configure the data and control VLANs for the EPSR domain:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 1000 name epsr-control
awplus(config-vlan)#vlan 2 name data
```

Configure the VLAN for the RSTP domain:

```
awplus(config-vlan)#vlan 10 name rstp-vlan
```

Configure the switch ports for the EPSR domain:

```
awplus(config-vlan)#interface port1.0.1-port1.0.2
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 1000,2
awplus(config-if)#switchport trunk native vlan none
```

Configure the switch ports for the RSTP domain:

```
awplus(config-if)#interface port1.0.10-port1.0.11
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 10
```

Configure the EPSR domain. This device is a transit node:

```
awplus(config-if)#epsr configuration
awplus(config-epsr)#epsr domain1 mode transit controlvlan 1000
awplus(config-epsr)#epsr domain1 datavlan 2
```

Enable EPSR:

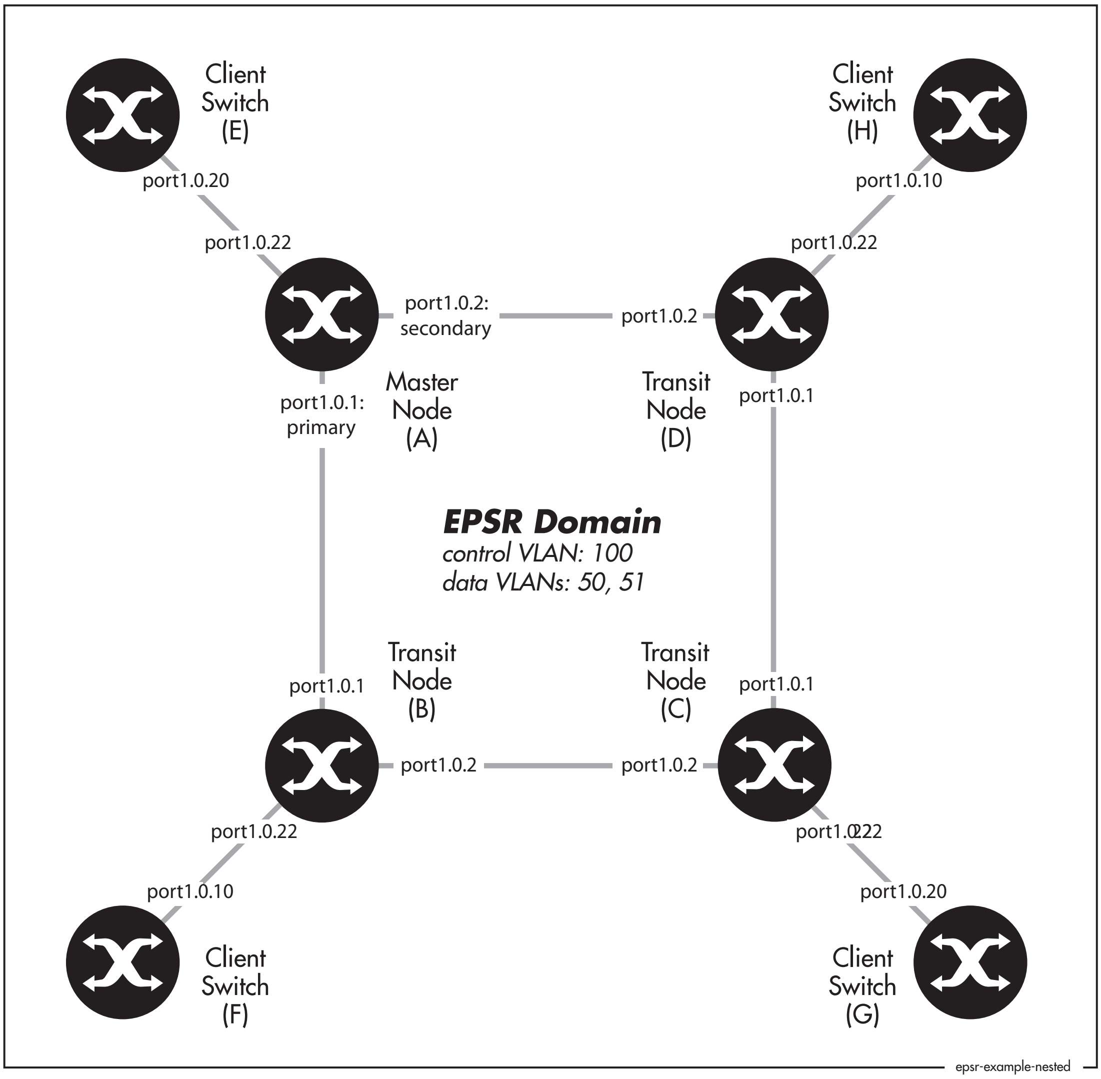
```
awplus(config-epsr)#epsr domain1 state enabled
awplus(config-epsr)#end
```

Note that although RSTP is enabled by default on AlliedWare Plus switches, it is automatically disabled on EPSR ports.

Example 4: EPSR with Nested VLANs

In this example:

- client switches A and C are in the same end-user VLAN (vlan20)
- client switches B and D are in the same end-user VLAN (vlan200)
- traffic for vlan20 is nested inside vlan 50 for transmission around the core
- traffic for vlan200 is nested inside vlan51 for transmission around the core
- vlan50 and vlan51 are data VLANs for the EPSR domain
- vlan100 is the control VLAN for the EPSR domain



1. Configure the master node (switch A) for the EPSR domain

Enter global configuration mode and enter the following commands:

Configure the EPSR control and data VLANs:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 100 name epsr-control
awplus(config-vlan)#vlan 50 name data-c1
awplus(config-vlan)#vlan 51 name data-c2
```

Note that in this example the data VLAN is also the nested VLAN.

Configure the switch ports:

```
awplus(config-vlan)#interface port1.0.22
awplus(config-if)#switchport access vlan 50
awplus(config-if)#switchport vlan-stacking customer-edge-port
awplus(config-if)#interface port1.0.1-port1.0.2
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 100,50,51
awplus(config-if)#switchport trunk native vlan none
awplus(config-if)#switchport vlan-stacking provider-port
```

Configure the EPSR domain. This switch is the master node:

```
awplus(config-if)#epsr configuration
awplus(config-epsr)#epsr awplus mode master controlvlan 100
   primaryport port1.0.1
awplus(config-epsr)#epsr awplus datavlan 50-51
```

Enable EPSR:

```
awplus(config-epsr)#epsr awplus state enabled
awplus(config-epsr)#exit
```

2. Configure transit node C for the EPSR domain

Each of the transit nodes has the same EPSR configuration in this example.

Enter global configuration mode and enter the following commands:

Configure the EPSR control and data VLANs:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 100 name epsr-control
awplus(config-vlan)#vlan 50 name data-c1
awplus(config-vlan)#vlan 51 name data-c2
```

Note that in this example the control VLAN is also the nested VLAN.

Configure the switch ports:

```
awplus(config-vlan)#interface port1.0.22
awplus(config-if)#switchport access vlan 50
awplus(config-if)#switchport vlan-stacking customer-edge-port
awplus(config-if)#interface port1.0.1-port1.0.2
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 100,50,51
awplus(config-if)#switchport trunk native vlan none
awplus(config-if)#switchport vlan-stacking provider-port
```

Configure the EPSR domain:

```
awplus(config-if)#epsr configuration
awplus(config-epsr)#epsr awplus mode transit controlvlan 100
awplus(config-epsr)#epsr awplus datavlan 50-51
```

Enable EPSR:

```
awplus(config-epsr)#epsr awplus state enabled
awplus(config-epsr)#exit
```

3. Configure transit nodes B and D for the EPSR domain

Each of the transit nodes has the same EPSR configuration in this example.

Enter global configuration mode and enter the following commands:

Configure the EPSR control and data VLANs:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 100 name epsr-control
awplus(config-vlan)#vlan 50 name data-c1
awplus(config-vlan)#vlan 51 name data-c2
```

Note that in this example the control VLAN is also the nested VLAN.

Configure the switch ports:

```
awplus(config-vlan)#interface port1.0.22
awplus(config-if)#switchport access vlan 51
awplus(config-if)#switchport vlan-stacking customer-edge-port
awplus(config-if)#interface port1.0.1-port1.0.2
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 100,50,51
awplus(config-if)#switchport trunk native vlan none
awplus(config-if)#switchport vlan-stacking provider-port
```

Configure the EPSR domain:

```
awplus(config-if)#epsr configuration
awplus(config-epsr)#epsr awplus mode transit controlvlan 100
awplus(config-epsr)#epsr awplus datavlan 50-51
```

Enable EPSR:

```
awplus(config-epsr)#epsr awplus state enabled
awplus(config-epsr)#exit
```

4. Configure client switch E (connected to the master node)

Enter global configuration mode and enter the following commands:

Configure the end-user VLAN:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 20 name customer20
```

Configure an IP address on the end-user VLAN:

```
awplus(config-vlan)#interface vlan20
awplus(config-if)#ip address 192.168.20.10/24
```

Configure the port connected to the service provider network:

```
awplus(config-if)#interface port1.0.20
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 20
awplus(config-if)#end
```

5. Configure client switch F (connected to transit node B)

Enter global configuration mode and enter the following commands:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 200 name customer200
awplus(config-vlan)#interface vlan200
awplus(config-if)#ip address 192.168.200.1/24
awplus(config-if)#interface port1.0.10
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 20
awplus(config-if)#end
```

6. Configure client switch G (connected to transit node C)

Enter global configuration mode and enter the following commands:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 20 name customer20
awplus(config-vlan)#interface vlan20
awplus(config-if)#ip address 192.168.20.1/24
awplus(config-if)#interface port1.0.20
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 20
awplus(config-if)#end
```

7. Configure client switch H (connected to transit node D)

Enter global configuration mode and enter the following commands:

```
awplus(config)#vlan database
awplus(config-vlan)#vlan 200 name customer200
awplus(config-vlan)#interface vlan200
awplus(config-if)#ip address 192.168.200.10/24
awplus(config-if)#interface port1.0.10
awplus(config-if)#switchport mode trunk
awplus(config-if)#switchport trunk allowed vlan add 200
awplus(config-if)#end
```

Example 5: EPSR with an iMAP

This example is the same as "Example 1: A Basic Ring" on page 10 except that one of the three switches is an iMAP. We used an AT-TN7100 iMAP running 6.1.10. The ring ports on the iMAP are 5.0 and 5.1. The example first shows the configuration script for the iMAP as the master node, then as the transit node. For the configuration of the other two switches, see Example 1.

Configure the AT-TN7100 iMAP as Master Node

The following diagram shows a partial script for the iMAP, with the commands for configuring it as a EPSR master node and other relevant commands.

```
ADD IP INTERFACE=MGMT IPADDRESS=172.28.9.3 SUBNETMASK=255.255.255.0
CARD=ACTCFC GATEWAY=172.28.9.1
#
SET SWITCH AGEINGTIMER=300
#
SET SYSTEM PROVMODE=AUTO
SET SYSTEM GATEWAY=172.28.9.1
#
CREATE EPSR=awplus MASTER HELLOTIME=1 FAILOVERTIME=2 RINGFLAPTIME=0
#
CREATE VLAN=vlan2 VID=2 FORWARDINGMODE=STD
CREATE VLAN=vlan1000 VID=1000 FORWARDINGMODE=STD
#
ADD VLAN=2 INTERFACE=ETH:[5.0-1] FRAME=TAGGED
ADD VLAN=1000 INTERFACE=ETH:[5.0-1] FRAME=TAGGED
#
DELETE VLAN=1 INTERFACE=ETH:[5.0-1]
#
SET INTERFACE=ETH:[5.0-1] ACCEPTABLE=VLAN
#
ADD EPSR=awplus INTERFACE=ETH:[5.0] TYPE=PRIMARY
ADD EPSR=awplus INTERFACE=ETH:[5.1] TYPE=SECONDARY
ADD EPSR=awplus VLAN=1000 TYPE=CONTROL
ADD EPSR=awplus VLAN=2 TYPE=DATA
#
ENABLE EPSR=awplus
```

Checking the Master Node Configuration

To see a summary, use the command:

```
show epsr
```

The following diagram shows the expected output.

```
--- EPSR Domain Information -----------------------------------------------------

   EPSR Domain    Node Type Domain Status/  Control Interface(s) (PhysicalState,
                                 State        Vlan           Type, State)
 --------------- --------- --------------- ------- ----------------------------
 awplus             MASTER     EN/COMPLETE    1000    5.0 (UP,DNSTRM,FWDING ),
                                                    5.1 (UP,DNSTRM,BLOCKED)

---------------------------------------------------------------------------------
```

To see details, use the command:

```
show epsr=awplus
```

The following diagram shows the expected output.

```
--- EPSR Domain Information -----------------------------------------------------

 EPSR Domain Name...................... awplus
 EPSR Domain Node Type................. Master
 EPSR Domain State..................... COMPLETE
 MAC Address of Master Node............ 0000.CD28.0619
 EPSR Domain Status.................... Enabled
 Control Vlan.......................... 1000
 Primary Interface..................... 5.0
 Physical State of Primary Interface... UP
 Primary Interface Type................ DOWNSTREAM
 Primary Interface State............... FORWARDING
 Secondary Interface................... 5.1
 Physical State of Secondary Interface. UP
 Secondary Interface Type.............. DOWNSTREAM
 Secondary Interface State............. BLOCKED
 Hello Timer (seconds.................. 1
 Failover Timer (seconds).............. 2
 RingFlap Timer (seconds).............. 0
 Hello Time Remaining (seconds)........ 1
 Failover Time Remaining (seconds)..... 0
 RingFlap Time Remaining (seconds)..... 0
 Hello Sequence........................ 526
 Data Vlans............................ 2

---------------------------------------------------------------------------------
```

Configure the AT-TN7100 iMAP as a Transit Node

The following diagram shows a partial script for the iMAP, with the commands for configuring it as a transit node.

```
CREATE EPSR=awplus TRANSIT
#
CREATE VLAN=vlan2 VID=2 FORWARDINGMODE=STD
CREATE VLAN=vlan1000 VID=1000 FORWARDINGMODE=STD
#
DISABLE INTERFACE=0.0-0.15,1.0-1.15,2.0-2.15,4.0-4.1,5.0-5.1
#
ADD VLAN=2 INTERFACE=ETH:[5.0-1] FRAME=TAGGED
ADD VLAN=1000 INTERFACE=ETH:[5.0-1] FRAME=TAGGED
#
DELETE VLAN=1 INTERFACE=ETH:[5.0-1]
#
SET INTERFACE=0.0-0.15,1.0-1.15,2.0-2.15,4.0-4.1,5.0-5.1
    PROFILE=AutoProv
SET INTERFACE=ETH:[5.0-1] ACCEPTABLE=VLAN
#
ADD EPSR=awplus INTERFACE=ETH:[5.0-1]
ADD EPSR=awplus VLAN=1000 TYPE=CONTROL
ADD EPSR=awplus VLAN=2 TYPE=DATA
#
ENABLE EPSR=awplus
#
ENABLE INTERFACE=0.0-0.15,1.0-1.15,2.0-2.15,4.0-4.1,5.0-5.1
```

Checking the Transit Node Configuration

To see a summary, use the command:

```
show epsr
```

The following diagram shows the expected output.

```
--- EPSR Domain Information ---------------------------------------------------

   EPSR Domain    Node Type Domain Status/  Control Interface(s) (PhysicalState,
                            State           Vlan          Type, State)
 --------------- --------- --------------- ------- ----------------------------
 awplus              TRANSIT    EN/LINKS-UP    1000   5.0 (UP,UPSTRM,FWDING ),
                                                    5.1 (UP,DNSTRM,FWDING )

-------------------------------------------------------------------------------
```

To see details, use the command:

```
show epsr=awplus
```

The following diagram shows the expected output.

```
--- EPSR Domain Information -----------------------------------------------------

 EPSR Domain Name...................... awplus
 EPSR Domain Node Type................. Transit
 EPSR Domain State..................... LINKS-UP
 MAC Address of Master Node............ 0000.CD24.024F
 EPSR Domain Status.................... Enabled
 Control Vlan.......................... 1000
 Ring Interface # 1.................... 5.0
 Physical State of Ring Interface # 1.. UP
 Ring Interface # 1 Type............... UPSTREAM
 Ring Interface # 1 State.............. FORWARDING
 Ring Interface # 2.................... 5.1
 Physical State of Ring Interface # 2.. UP
 Ring Interface # 2 Type............... DOWNSTREAM
 Ring Interface # 2 State.............. FORWARDING
 Hello Timer (seconds.................. N/A
 Failover Timer (seconds).............. N/A
 Ringflap Timer (seconds).............. N/A
 Hello Time Remaining (seconds)........ N/A
 Failover Time Remaining (seconds)..... N/A
 Ringflap Time Remaining (seconds)..... N/A
 Hello Sequence........................ N/A
 Data Vlans............................ 2

--------------------------------------------------------------------------------
```

Classifiers and Hardware Filters

On SwitchBlade x908, AT-8948, AT-9900, AT-9900s, and x900 series switches, the switching hardware has a limit of 16 bytes to use for matching on incoming packets.

EPSR creates a hardware filter that uses 2 bytes for VLAN identification. This means that you have to design your network carefully when using EPSR with DHCP snooping, QoS, or other hardware filters.

For example:

- DHCP snooping uses 4 bytes to match on the source and destination UDP ports and the protocol field. With EPSR and DHCP snooping both enabled, 6 out of the 16 bytes are used.
- IP addresses use 4 bytes. So if you configured EPSR, DHCP snooping, and a QoS policy that classified on source IP address, then 10 of the 16 bytes would be used.

Ports and Recovery Times

In practice, recovery time in an EPSR ring is generally between 50 and 100ms. However, it depends on the port type, because this determines how long it takes for the port to report that it is down and send a Link-Down message.

The following ports report that they are down immediately or within a few milliseconds, which leads to an EPSR recovery time of 50 to 100ms:

- 10/100M copper RJ-45 ports
- tri-speed copper RJ-45 ports operating at 10 or 100M
- fiber 1000M ports
- 10G ports

However, for tri-speed copper RJ-45 ports operating at 1000M, there is a short delay before the port reports that it is down. For almost all networks, this slight delay in recovery has no practical effect. However, for networks with extremely stringent failover requirements, we recommend using fiber 1000M ports instead of copper.

IGMP Snooping and Recovery Times

From Software Version **5.3.2** onwards, IGMP snooping includes **query solicitation**, a feature that minimises loss of multicast data after a topology change.

When IGMP snooping is enabled on a VLAN, and EPSR changes the underlying link layer topology of that VLAN, this can interrupt multicast data flow for a significant length of time. Query solicitation prevents this by monitoring the VLAN for any topology changes. When it detects a change, it generates a special IGMP Leave message known as a Query Solicit, and floods the Query Solicit message to all ports. When the IGMP Querier receives the message, it responds by sending a General Query. This refreshes snooped group membership information in the network.

Query solicitation functions by default (without you enabling it) on the EPSR master node. By default, the master node always sends a Query Solicit message when the topology changes.

On other switches in the network, the query solicitation is disabled by default, but you can enable it by using the command:

```
awplus(config)#ip igmp snooping tcn query solicit
```

If you enable query solicitation on an EPSR transit node, both that node and the master node send a Query Solicit message. Once the Querier receives the Query Solicit message, it sends out a General Query and waits for responses, which update the snooping information throughout the network.

Within the IGMP query packets sent from the querier, there is a field, called the **Max Response Time**, that indicates to the clients how quickly they must respond to the query.

The value of this time can be configured on the Querier, using the command:

```
ip igmp query-max-response-time <responsetime>
```

By default, this time is 10 seconds. In order to ensure faster responses, to speed up the recovery of multicast services, it is advisable to reduce the query-max-response-time to 1 or 2 seconds.

Query solicitation also works with networks that use Spanning Tree (STP, RSTP, or MSTP).

Query flooding protection

It is possible for an IGMP Querier to be flooded with Query Solicit packets and, in response, generate large numbers of IGMP Queries. This could potentially congest the network.

To prevent this kind of flooding, the AlliedWare Plus OS has an IGMP Query-Hold Interval. This is the time, starting from the last Query sent, that an IGMP Querier refrains from sending any more IGMP Queries. You can configure this time period on each VLAN interface, using the command:

```
awplus(config-if)#ip igmp query-holdtime <100-5000>
```

where <100-5000> is the time in milliseconds for the hold interval. The default is 500 milliseconds. This hold time is always enabled, and does not require Query Solicitation to be enabled.

Health Message Priority

EPSR uses Health messages to check that the ring is intact. If switches in the ring were to drop Health messages, this could make the ring unstable. Therefore, Health messages are sent to the highest priority queue (queue 7), which uses strict priority scheduling by default. This makes sure that the switches forward Health messages even if the network is congested.

We recommend that you leave queue 7 as the highest priority queue, leave it using strict priority scheduling, and only send essential control traffic to it.

In the unlikely event that this is impossible, you can increase the failover time so that the master node only changes the ring topology if several Health messages in a row fail to arrive. By default, the failover time is set to two seconds, which means that the master node decides that the ring is down if two Health messages in a row fail to arrive.

EPSR State and Settings

To display the EPSR state, the attached VLANs, the ring ports, and the timer values, use the command:

```
show epsr
```

Master Node in a Complete Ring

The following diagram shows the output for a master node in a ring that is in a state of Complete. As well as giving the state as Complete, it also shows that port1.0.1 is the primary port and port1.0.2 is the secondary port. Note that the secondary port is blocked, so does not forward packets over the data VLAN (vlan2).

```
 EPSR Information
------------------------------------------------------------------------
 Name ........................ test
 Mode .......................... Master
 Status ........................ Enabled
 State ......................... Complete
 Control Vlan .................. 1000
 Data VLAN(s) .................. 2
 Primary Port .................. port1.0.1
 Primary Port Status ........... Forwarding
 Secondary Port ................ port1.0.2
 Secondary Port Status ......... Blocked
 Hello Time .................... 1 s
 Failover Time ................. 2 s
 Ring Flap Time ................ 0 s
 Trap .......................... Enabled
------------------------------------------------------------------------
```

Transit Node in a Complete Ring

The following diagram shows the output for a transit node in a ring that is in a state of Complete. Note that the State is Links-Up, not Complete. Only the master node shows Complete as the state.

```
 EPSR Information
------------------------------------------------------------------------
 Name ........................ test
 Mode .......................... Transit
 Status ........................ Enabled
 State ......................... Links-Up
 Control Vlan .................. 1000
 Data VLAN(s) .................. 2
 First Port .................... port1.0.1
 First Port Status ............. Forwarding
 First Port Direction .......... Upstream
 Second Port ................... port1.0.2
 Second Port Status ............ Forwarding
 Second Port Direction ......... Downstream
 Trap .......................... Enabled
 Master Node ................... 00-00-cd-28-06-19
------------------------------------------------------------------------
```

Master Node in a Failed Ring

In contrast, the following diagram shows the output for a master node in a ring that is in a Failed state. Both ring ports are now forwarding.

```
EPSR Information
------------------------------------------------------------------------
Name ........................ domain1
Mode .......................... Master
Status ........................ Enabled
State ......................... Failed
Control Vlan .................. 1000
Data VLAN(s) .................. 2
Primary Port .................. port1.0.1
Primary Port Status ........... Forwarding
Secondary Port ................ port1.0.2
Secondary Port Status ......... Forwarding
Hello Time .................... 1 s
Failover Time ................. 2 s
Ring Flap Time ................ 0 s
Trap .......................... Enabled
------------------------------------------------------------------------
```

SNMP Traps

You can use SNMP traps to notify you when events occur in the EPSR ring.

Download the latest version of the Allied Telesis Enterprise MIB from www.alliedtelesis.co.nz/support/updates/patches.html. The EPSR Group is contained in the sub-file called at-epsrv2.mib.

The EPSR Group has the object identifier prefix epsrv2 (module 536), and contains a collection of objects and traps for monitoring EPSR states.

The following trap is defined under the epsrv2Events subtree:

- atEpsrv2NodeTrap is the trap type of the EPSR node (master/transit).

The following objects are defined under the epsrv2EventVariables subtree:

- atEpsrv2NodeType is the type of the EPSR node (master/transit).
- atEpsrv2DomainName is the name assigned to the EPSR domain.
- atEpsrv2DomainID is a domain index variable used by the AlliedWare Plus GUI.
- atEpsrv2FromState is the defined state that an EPSR domain is transitioning from.
- atEpsrv2CurrentState is the state that an EPSR domain is transitioning to.
- atEpsrv2ControlVlanId is the VLAN identifier for the control VLAN.
- atEpsrv2PrimaryIfIndex is the ifIndex of the primary interface.
- atEpsrv2PrimaryIfState is the current state of the primary interface.
- atEpsrv2SecondaryIfIndex is the ifIndex of the secondary interface.
- atEpsrv2SecondaryIfState is the current state of the secondary interface.

Counters

The EPSR counters record the number of EPSR messages that the CPU received and transmitted. To display the counters, use the command:

```
show epsr <epsr-name> count
```

Master node in a Complete ring

The following diagram shows the counters for a master node in a ring that has never had a link or node fail.

```
EPSR Counters
------------------------------------------------------------------------
Name: domain1
 Receive:                                  Transmit:
 Total EPSR Packets           1093         Total EPSR Packets         1093
 Health                       1092         Health                     1092
 Ring Up                      1            Ring Up                    1
 Ring Down                    0            Ring Down                  0
 Link Down                    0            Link Down                  0
 Invalid EPSR Packets         0
------------------------------------------------------------------------
```

Note that the node has generated 1093 EPSR packets (and sent them out its primary port) and has received the same number of EPSR packets (on its secondary port).

However, it is very common to see a few Link Down, Ring Down, and Ring Up entries in the output of a ring that has never been in a Failed state. These messages are produced when you first enable EPSR, if some ring nodes establish before others.

Transit Node in a ring that had failures

In contrast, the following diagram shows the counters for a transit node in a ring that has been in a Failed state twice.

```
EPSR Counters
------------------------------------------------------------------------
Name: domain1
 Receive:                                  Transmit:
 Total EPSR Packets           1425         Total EPSR Packets         2
 Health                       1423         Health                     0
 Ring Up                      2            Ring Up                    0
 Ring Down                    0            Ring Down                  0
 Link Down                    0            Link Down                  2
 Invalid EPSR Packets         0
------------------------------------------------------------------------
```

Here, the transit node has received 1421 Health messages, which it will have forwarded on if its ports were up. These messages do not show in the transmit counters because they are transmitted by the switching hardware, not the CPU.

The node has also generated two Link-Down messages, indicating that on two separate occasions one of its links has gone down.

Debugging

This section walks you through the EPSR debugging output as links go down and come back up again. The debugging output comes from the ring in "Example 1: A Basic Ring" on page 10. The output shows what happened when we took down two separate links in turn:

- first, the link between the master node's primary port and transit node B
- second, the link between the two transit nodes B and C

To enable debugging, enter the commands:

```
awplus#terminal monitor
awplus#debug epsr all
```

The **terminal monitor** command causes the switch to display *terminal logging* messages on the console. By default, debug messages are terminal logging messages. You can change this by using the **log terminal** command in global configuration mode. You can see which messages are saved into each type of log by using the **show log config** command.

Note that the master node transmits Health messages every second by default. The debugging displays every message, including all Health messages. Therefore, we recommend that you capture the debugging output for separate analysis, to make analysis simpler.

Link Down Between Master Node and Transit Node

This section shows the debugging output when the link between the master node's primary port and transit node B goes down and comes back up again. It shows the debugging output for the complete failure and recovery cycle:

- first on the master node
- then on transit node B.

Master Node (Node A) Debug Output

The following debugging output starts with the ring established and in a state of Complete.

1. The master node sends Health messages

Each time the Hello timer expires, the master node sends a Health message out its primary port (port1.0.1). As long as the ring is in a state of Complete, it receives each Health message again on its secondary port (port1.0.2). Note that in the System field, this output shows the MAC address of the source of the message—the master node in this case.

```
13:49:18 EPSR[1296]: EPSR: epsrHelloTimeout: EPSR awplus Hello Timer expired
13:49:18 EPSR[1296]: EPSR: port1.0.1 Tx:
13:49:18 EPSR[1296]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
13:49:18 EPSR[1296]: EPSR:  00bb0100 005405f1 00000000 0000cd24 0331990b 00400105
13:49:18 EPSR[1296]: EPSR:  03e80000 00000000 cd240331 00010002 01001fcf 00000000
13:49:18 EPSR[1296]: EPSR: port1.0.1 Tx:
13:49:18 EPSR[1296]: EPSR: ---------------------------------------------------------------
13:49:18 EPSR[1296]: EPSR:          TYPE = HEALTH                     STATE = COMPLETE
13:49:18 EPSR[1296]: EPSR:      CTRL VLAN = 1000                     SYSTEM = 0000.cd24.0331
13:49:18 EPSR[1296]: EPSR:     HELLO TIME = 1                     FAIL TIME = 2
13:49:18 EPSR[1296]: EPSR:      HELLO SEQ = 8143
13:49:18 EPSR[1296]: EPSR: ---------------------------------------------------------------
13:49:18 EPSR[1296]: EPSR: port1.0.2 Rx:
13:49:18 EPSR[1296]: EPSR:  00e02b00 00040000 cd240331 810003e8 005caaaa 0300e02b
13:49:18 EPSR[1296]: EPSR:  00bb0100 005405f1 00000000 0000cd24 0331990b 00400105
13:49:18 EPSR[1296]: EPSR:  03e80000 00000000 cd240331 00010002 01001fcf 00000000
13:49:18 EPSR[1296]: EPSR: port1.0.2 Rx:
13:49:18 EPSR[1296]: EPSR: ---------------------------------------------------------------
13:49:18 EPSR[1296]: EPSR:          TYPE = HEALTH                     STATE = COMPLETE
13:49:18 EPSR[1296]: EPSR:      CTRL VLAN = 1000                     SYSTEM = 0000.cd24.0331
13:49:18 EPSR[1296]: EPSR:     HELLO TIME = 1                     FAIL TIME = 2
13:49:18 EPSR[1296]: EPSR:      HELLO SEQ = 8143
13:49:18 EPSR[1296]: EPSR: ---------------------------------------------------------------
```

2. The master node continues sending Health messages

The master node continues sending Health messages, and increments the Hello Sequence number with each message. If all nodes and links in the ring are intact, these Health messages are the only debugging output you see.

```
 .
 .
 .
13:52:10 EPSR[1296]: EPSR: epsrHelloTimeout: EPSR awplus Hello Timer expired
13:52:10 EPSR[1296]: EPSR: port1.0.1 Tx:
13:52:10 EPSR[1296]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
13:52:10 EPSR[1296]: EPSR:  00bb0100 00540545 00000000 0000cd24 0331990b 00400105
13:52:10 EPSR[1296]: EPSR:  03e80000 00000000 cd240331 00010002 0100207b 00000000
13:52:10 EPSR[1296]: EPSR: port1.0.1 Tx:
13:52:10 EPSR[1296]: EPSR: --------------------------------------------------------------
13:52:10 EPSR[1296]: EPSR:          TYPE = HEALTH                     STATE = COMPLETE
13:52:10 EPSR[1296]: EPSR:     CTRL VLAN = 1000                      SYSTEM = 00-00-cd-24-03-31
13:52:10 EPSR[1296]: EPSR:    HELLO TIME = 1                      FAIL TIME = 2
13:52:10 EPSR[1296]: EPSR:     HELLO SEQ = 8420
13:52:10 EPSR[1296]: EPSR: --------------------------------------------------------------
13:52:10 EPSR[1296]: EPSR: port1.0.2 Rx:
13:52:10 EPSR[1296]: EPSR:  00e02b00 00040000 cd240331 810003e8 005caaaa 0300e02b
13:52:10 EPSR[1296]: EPSR:  00bb0100 00540545 00000000 0000cd24 0331990b 00400105
13:52:10 EPSR[1296]: EPSR:  03e80000 00000000 cd240331 00010002 0100207b 00000000
13:52:10 EPSR[1296]: EPSR: port1.0.2 Rx:
13:52:10 EPSR[1296]: EPSR: --------------------------------------------------------------
13:52:10 EPSR[1296]: EPSR:          TYPE = HEALTH                     STATE = COMPLETE
13:52:10 EPSR[1296]: EPSR:     CTRL VLAN = 1000                      SYSTEM = 00-00-cd-24-03-31
13:52:10 EPSR[1296]: EPSR:    HELLO TIME = 1                      FAIL TIME = 2
13:52:10 EPSR[1296]: EPSR:     HELLO SEQ = 8420
13:52:10 EPSR[1296]: EPSR: --------------------------------------------------------------
```

3. The primary port goes down

The link between the master node's primary port and the neighbouring transit node goes down. Therefore, the master node detects that its primary port (port1.0.1) has gone down.

```
13:53:45 EPSR[1296]: EPSR: EPSR awplus, ifIndex 5001 down
13:53:45 EPSR[1296]: EPSR: Flush FDB EPSR: awplus  vid: 2
13:53:45 EPSR[1296]: EPSR: EPSR awplus: port 5001 is down
```

4. The master node receives a Link-Down message on its secondary port

The master node receives a Link-Down message on its secondary port (port1.0.2) from transit node B, which is at the other end of the broken link.

```
13:53:45 EPSR[1296]: EPSR: port1.0.2 Rx:
13:53:45 EPSR[1296]: EPSR:  00e02b00 00040000 cd127808 810003e8 005caaaa 0300e02b
13:53:45 EPSR[1296]: EPSR:  00bb0100 00543935 00000000 0000cd12 7808990b 00400108
13:53:45 EPSR[1296]: EPSR:  03e80000 00000000 cd127808 00000000 04000000 00000000
13:53:45 EPSR[1296]: EPSR: port1.0.2 Rx:
13:53:45 EPSR[1296]: EPSR: --------------------------------------------------------------
13:53:45 EPSR[1296]: EPSR:          TYPE = LINK-DOWN                 STATE = LINK-DOWN
13:53:45 EPSR[1296]: EPSR:     CTRL VLAN = 1000                     SYSTEM = 0000.cd12.7808
13:53:45 EPSR[1296]: EPSR:    HELLO TIME = 0                     FAIL TIME = 0
13:53:45 EPSR[1296]: EPSR:     HELLO SEQ = 0
13:53:45 EPSR[1296]: EPSR: --------------------------------------------------------------
13:53:45 EPSR[1296]: EPSR: EPSR awplus: link down msg from 00-00-cd-12-78-08
```

In the System field, this output shows the MAC address of the source of the message—the transit node in this case.

5. The master node transmits a Ring-Down-Flush-FDB message

The master switch responds to the break in the ring by sending a Ring-Down-Flush-FDB message, which tells each transit node to learn the new topology. The master node also unblocks its secondary port for the data VLAN (vlan2), flushes its FDB, sends an SNMP trap, and changes the EPSR state to Failed. Note that the master node sends the Ring-Down-Flush-FDB message only out its secondary port, because the link between the primary port and the neighbouring transit node is down.

```
13:53:45 EPSR[1296]: EPSR: port1.0.2 Tx:
13:53:45 EPSR[1296]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
13:53:45 EPSR[1296]: EPSR:  00bb0100 005424c1 00000000 0000cd24 0331990b 00400107
13:53:45 EPSR[1296]: EPSR:  03e80000 00000000 cd240331 00000000 02000000 00000000
13:53:45 EPSR[1296]: EPSR: port1.0.2 Tx:
13:53:45 EPSR[1296]: EPSR: --------------------------------------------------------------
13:53:45 EPSR[1296]: EPSR:          TYPE = RING-DOWN-FLUSH-FDB       STATE = FAILED
13:53:45 EPSR[1296]: EPSR:     CTRL VLAN = 1000                     SYSTEM = 0000.cd24.0331
13:53:45 EPSR[1296]: EPSR:    HELLO TIME = 0                     FAIL TIME = 0
13:53:45 EPSR[1296]: EPSR:     HELLO SEQ = 0
13:53:45 EPSR[1296]: EPSR: --------------------------------------------------------------
13:53:45 EPSR[1296]: EPSR: Unblock EPSR:awplus port:5002 VLAN:2
13:53:45 EPSR[1296]: EPSR: EPSR awplus: port 5002 is forwarding
13:53:45 EPSR[1296]: EPSR: Flush FDB EPSR: awplus  vid: 2
13:53:45 EPSR[1296]: EPSR: awplus oldState:COMPLETE newState:FAILED
13:53:45 EPSR[1296]: EPSR: EPSR awplus: ring failed
```

6. The Hello timer expires

The Hello timer expires, which would normally trigger the master node to send a Health message out the primary port. However, the link between the primary port and the neighbouring transit node is down, so the master node does not send the Health message.

```
13:53:46 EPSR[1296]: EPSR: epsrHelloTimeout: EPSR awplus Hello Timer expired
13:53:47 EPSR[1296]: EPSR: epsrHelloTimeout: EPSR awplus Hello Timer expired
13:53:48 EPSR[1296]: EPSR: epsrHelloTimeout: EPSR awplus Hello Timer expired
13:53:49 EPSR[1296]: EPSR: epsrHelloTimeout: EPSR awplus Hello Timer expired
```

7. The primary port comes back up

The primary port comes back up. The master node immediately blocks that port for vlan2 to prevent a loop.

```
14:05:03 EPSR[1296]: EPSR: EPSR awplus, ifIndex 5001 up
14:05:03 EPSR[1296]: EPSR: Block EPSR:awplus port:5001 VLAN:2
14:05:03 EPSR[1296]: EPSR: EPSR awplus: port 5001 is blocking
```

8. The Hello timer expires again

The Hello timer expires again. Port1.0.1 is now up, so this time the master node sends a Health message. The Health message shows that the EPSR state is Failed.

Note that the Hello Sequence number increments from the number it was before the primary port went down, because the master node could not transmit Health messages while the port was down.

```
14:05:03 EPSR[1296]: EPSR: epsrHelloTimeout: EPSR awplus Hello Timer expired
14:05:03 EPSR[1296]: EPSR: port1.0.1 Tx:
14:05:03 EPSR[1296]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
14:05:03 EPSR[1296]: EPSR:  00bb0100 005403db 00000000 0000cd24 0331990b 00400105
14:05:03 EPSR[1296]: EPSR:  03e80000 00000000 cd240331 00010002 020020e5 00000000
14:05:03 EPSR[1296]: EPSR: port1.0.1 Tx:
14:05:03 EPSR[1296]: EPSR: --------------------------------------------------------------
14:05:03 EPSR[1296]: EPSR:          TYPE = HEALTH                        STATE = FAILED
14:05:03 EPSR[1296]: EPSR:     CTRL VLAN = 1000                         SYSTEM = 00-00-cd-24-03-31
14:05:03 EPSR[1296]: EPSR:    HELLO TIME = 1                         FAIL TIME = 2
14:05:03 EPSR[1296]: EPSR:     HELLO SEQ = 8421
14:05:03 EPSR[1296]: EPSR: --------------------------------------------------------------
```

9. The master node receives the Health message on its secondary port

The master node receives the Health message on its secondary port (port1.0.2). This tells it that all links on the ring are up again.

```
14:05:03 EPSR[1296]: EPSR: port1.0.2 Rx:
14:05:03 EPSR[1296]: EPSR:  00e02b00 00040000 cd240331 810003e8 005caaaa 0300e02b
14:05:03 EPSR[1296]: EPSR:  00bb0100 005403db 00000000 0000cd24 0331990b 00400105
14:05:03 EPSR[1296]: EPSR:  03e80000 00000000 cd240331 00010002 020020e5 00000000
14:05:03 EPSR[1296]: EPSR: port1.0.2 Rx:
14:05:03 EPSR[1296]: EPSR: --------------------------------------------------------------
14:05:03 EPSR[1296]: EPSR:          TYPE = HEALTH                       STATE = FAILED
14:05:03 EPSR[1296]: EPSR:     CTRL VLAN = 1000                        SYSTEM = 00-00-cd-24-03-31
14:05:03 EPSR[1296]: EPSR:    HELLO TIME = 1                        FAIL TIME = 2
14:05:03 EPSR[1296]: EPSR:     HELLO SEQ = 8421
14:05:03 EPSR[1296]: EPSR: --------------------------------------------------------------
```

10. The master node returns the ring to a state of Complete

The master node blocks its secondary port for the data VLAN, unblocks its primary port, transmits a Ring-Up-Flush-FDB message, flushes its FDB, sends a trap, and changes the EPSR state to Complete.

```
14:05:03 EPSR[1296]: EPSR: Block EPSR:awplus port:5002 VLAN:2
14:05:03 EPSR[1296]: EPSR: EPSR awplus: port 5002 is blocking
14:05:03 EPSR[1296]: EPSR: Unblock EPSR:awplus port:5001 VLAN:2
14:05:03 EPSR[1296]: EPSR: EPSR awplus: port 5001 is forwarding
14:05:03 EPSR[1296]: EPSR: port1.0.1 Tx:
14:05:03 EPSR[1296]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
14:05:03 EPSR[1296]: EPSR:  00bb0100 005425c2 00000000 0000cd24 0331990b 00400106
14:05:03 EPSR[1296]: EPSR:  03e80000 00000000 cd240331 00000000 01000000 00000000
14:05:03 EPSR[1296]: EPSR: port1.0.1 Tx:
14:05:03 EPSR[1296]: EPSR: --------------------------------------------------------------
14:05:03 EPSR[1296]: EPSR:          TYPE = RING-UP-FLUSH-FDB            STATE = COMPLETE
14:05:03 EPSR[1296]: EPSR:     CTRL VLAN = 1000                        SYSTEM = 00-00-cd-24-03-31
14:05:03 EPSR[1296]: EPSR:    HELLO TIME = 0                        FAIL TIME = 0
14:05:03 EPSR[1296]: EPSR:     HELLO SEQ = 0
14:05:03 EPSR[1296]: EPSR: --------------------------------------------------------------
14:05:03 EPSR[1296]: EPSR: Flush FDB EPSR: awplus  vid: 2
14:05:03 EPSR[1296]: EPSR: awplus oldState:FAILED newState:COMPLETE
14:05:03 EPSR[1296]: EPSR: EPSR awplus: ring complete
```

11. The master node receives the Ring-Up-Flush-FDB message on port1.0.2

The master node receives the Ring-Up-Flush-FDB message back on its secondary port, because the packet traversed the whole ring. The master node ignores the message.

```
14:05:03 EPSR[1296]: EPSR: port1.0.2 Rx:
14:05:03 EPSR[1296]: EPSR:  00e02b00 00040000 cd240331 810003e8 005caaaa 0300e02b
14:05:03 EPSR[1296]: EPSR:  00bb0100 005425c2 00000000 0000cd24 0331990b 00400106
14:05:03 EPSR[1296]: EPSR:  03e80000 00000000 cd240331 00000000 01000000 00000000
14:05:03 EPSR[1296]: EPSR: port1.0.2 Rx:
14:05:03 EPSR[1296]: EPSR: ---------------------------------------------------------------
14:05:03 EPSR[1296]: EPSR:          TYPE = RING-UP-FLUSH-FDB         STATE = COMPLETE
14:05:03 EPSR[1296]: EPSR:     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-03-31
14:05:03 EPSR[1296]: EPSR:    HELLO TIME = 0                     FAIL TIME = 0
14:05:03 EPSR[1296]: EPSR:     HELLO SEQ = 0
14:05:03 EPSR[1296]: EPSR: ---------------------------------------------------------------
```

12. The master node transmits and receives Health messages

The master node continues transmitting and receiving Health messages for as long as the ring stays in a state of Complete.

```
14:05:04 EPSR[1296]: EPSR: epsrHelloTimeout: EPSR awplus Hello Timer expired
14:05:04 EPSR[1296]: EPSR: port1.0.1 Tx:
14:05:04 EPSR[1296]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
14:05:04 EPSR[1296]: EPSR:  00bb0100 005404da 00000000 0000cd24 0331990b 00400105
14:05:04 EPSR[1296]: EPSR:  03e80000 00000000 cd240331 00010002 010020e6 00000000
14:05:04 EPSR[1296]: EPSR: port1.0.1 Tx:
14:05:04 EPSR[1296]: EPSR: ---------------------------------------------------------------
14:05:04 EPSR[1296]: EPSR:          TYPE = HEALTH                    STATE = COMPLETE
14:05:04 EPSR[1296]: EPSR:     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-03-31
14:05:04 EPSR[1296]: EPSR:    HELLO TIME = 1                     FAIL TIME = 2
14:05:04 EPSR[1296]: EPSR:     HELLO SEQ = 8422
14:05:04 EPSR[1296]: EPSR: ---------------------------------------------------------------
14:05:04 EPSR[1296]: EPSR: port1.0.2 Rx:
14:05:04 EPSR[1296]: EPSR:  00e02b00 00040000 cd240331 810003e8 005caaaa 0300e02b
14:05:04 EPSR[1296]: EPSR:  00bb0100 005404da 00000000 0000cd24 0331990b 00400105
14:05:04 EPSR[1296]: EPSR:  03e80000 00000000 cd240331 00010002 010020e6 00000000
14:05:04 EPSR[1296]: EPSR: port1.0.2 Rx:
14:05:04 EPSR[1296]: EPSR: ---------------------------------------------------------------
14:05:04 EPSR[1296]: EPSR:          TYPE = HEALTH                    STATE = COMPLETE
14:05:04 EPSR[1296]: EPSR:     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-03-31
14:05:04 EPSR[1296]: EPSR:    HELLO TIME = 1                     FAIL TIME = 2
14:05:04 EPSR[1296]: EPSR:     HELLO SEQ = 8422
14:05:04 EPSR[1296]: EPSR: ---------------------------------------------------------------
  .
  .
  .
```

Transit Node (Node B) Debug Output

The following debugging shows the same sequence of events as the previous section, but on the transit node instead of the master node. It starts with the ring established and in a state of Complete.

Note that the following debug was captured at a different time (during a different ring-down event) from the master node debug in the previous section. This is why the times and hello sequence numbers do not match.

1. The transit node receives Health messages

The transit node receives Health messages on port1.0.1, because that port is connected to the master node's primary port. Note that in the System field, this output shows the MAC address of the source of the message—the master node in this case.

This is equivalent to the packet shown in step 1 on page 35 of the master node debug output.

```
10:45:38 EPSR[1284]: EPSR: port1.0.1 Rx:
10:45:38 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:45:38 EPSR[1284]: EPSR:  00bb0100 005422a9 00000000 0000cd24 0331990b 00400105
10:45:38 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00010002 0100052d 00000000
10:45:38 EPSR[1284]: EPSR: port1.0.1 Rx:
10:45:38 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:45:38 EPSR[1284]: EPSR:          TYPE = HEALTH                        STATE = COMPLETE
10:45:38 EPSR[1284]: EPSR:     CTRL VLAN = 1000                         SYSTEM = 0000.cd24.0331
10:45:38 EPSR[1284]: EPSR:    HELLO TIME = 1                         FAIL TIME = 2
10:45:38 EPSR[1284]: EPSR:     HELLO SEQ = 1325
10:45:38 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:45:39 EPSR[1284]: EPSR: port1.0.1 Rx:
10:45:39 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:45:39 EPSR[1284]: EPSR:  00bb0100 005422a8 00000000 0000cd24 0331990b 00400105
10:45:39 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00010002 0100052e 00000000
10:45:39 EPSR[1284]: EPSR: port1.0.1 Rx:
10:45:39 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:45:39 EPSR[1284]: EPSR:          TYPE = HEALTH                        STATE = COMPLETE
10:45:39 EPSR[1284]: EPSR:     CTRL VLAN = 1000                         SYSTEM = 0000.cd24.0331
10:45:39 EPSR[1284]: EPSR:    HELLO TIME = 1                         FAIL TIME = 2
10:45:39 EPSR[1284]: EPSR:     HELLO SEQ = 1326
10:45:39 EPSR[1284]: EPSR: -----------------------------------------------------------------
```

2. Port1.0.1 on the transit node goes down

The transit node detects that port1.0.1 (between the transit node and the master node) has gone down. The transit node flushes its forwarding database, blocks port1.0.1 for the data VLAN (to prevent a loop from forming when the master node comes back up), sends a Link-Down message towards the master node, sends a trap, and changes the EPSR state to Link-Down.

This is equivalent to the packet shown in step 4 on page 37 of the master node debug output.

```
10:46:10 EPSR[1284]: EPSR: EPSR awplus, ifIndex 5001 down
10:46:10 EPSR[1284]: EPSR: Flush FDB EPSR: awplus  vid: 2
10:46:10 EPSR[1284]: EPSR: EPSR awplus: port 5001 is down
10:46:10 EPSR[1284]: EPSR: Block EPSR:awplus port:5001 VLAN:2
10:46:10 EPSR[1284]: EPSR: port1.0.2 Tx:
10:46:10 EPSR[1284]: EPSR:  00e02b00 00040000 cd247808 8100e3e8 005caaaa 0300e02b
10:46:10 EPSR[1284]: EPSR:  00bb0100 005422c0 00000000 0000cd24 7808990b 00400108
10:46:10 EPSR[1284]: EPSR:  03e80000 00000000 cd247808 00000000 04000000 00000000
10:46:10 EPSR[1284]: EPSR: port1.0.2 Tx:
10:46:10 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:46:10 EPSR[1284]: EPSR:          TYPE = LINK-DOWN                  STATE = LINK-DOWN
10:46:10 EPSR[1284]: EPSR:     CTRL VLAN = 1000                      SYSTEM = 00-00-cd-24-78-08
10:46:10 EPSR[1284]: EPSR:    HELLO TIME = 0                      FAIL TIME = 0
10:46:10 EPSR[1284]: EPSR:     HELLO SEQ = 0
10:46:10 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:46:10 EPSR[1284]: EPSR: awplus oldState:LINK-UP newState:LINK-DOWN
```

3. The transit node receives a Ring-Down-Flush-FDB message.

In response to the Link-Down message, the master node sends a Ring-Down-Flush-FDB message. However, this transit node does not need to flush its database—it already did.

This is equivalent to the packet shown in step 5 on page 37 of the master node debug output.

```
10:46:10 EPSR[1284]: EPSR: port1.0.2 Rx:
10:46:10 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:46:10 EPSR[1284]: EPSR:  00bb0100 005426d7 00000000 0000cd24 0331990b 00400107
10:46:10 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00000000 02000000 00000000
10:46:10 EPSR[1284]: EPSR: port1.0.2 Rx:
10:46:10 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:46:10 EPSR[1284]: EPSR:          TYPE = RING-DOWN-FLUSH-FDB        STATE = FAILED
10:46:10 EPSR[1284]: EPSR:     CTRL VLAN = 1000                      SYSTEM = 00-00-cd-24-03-31
10:46:10 EPSR[1284]: EPSR:    HELLO TIME = 0                      FAIL TIME = 0
10:46:10 EPSR[1284]: EPSR:     HELLO SEQ = 0
10:46:10 EPSR[1284]: EPSR: -----------------------------------------------------------------
```

4. Port1.0.1 comes back up

The transit node detects that port1.0.1 has come back up. It sends a trap and changes the EPSR state to Pre-forwarding. Note that it leaves port1.0.1 blocked for vlan2, to make sure there are no loops.

```
10:47:27 EPSR[1284]: EPSR: Block EPSR:awplus port:5001 VLAN:2
10:47:27 EPSR[1284]: EPSR: EPSR awplus: port 5001 is blocking
10:47:27 EPSR[1284]: EPSR: EPSR awplus, ifIndex 5001 up
10:47:27 EPSR[1284]: EPSR: awplus oldState:LINK-DOWN newState:PRE-FORWARDING
```

5. Transit node receives a Health message

Now that the master node's primary port is up again, it sends a Health message. Now that the transit node's port1.0.1 is up again for the control VLAN, the transit node receives the message. This demonstrates that the transit node has only blocked port1.0.1 for the data VLAN, not the control VLAN. EPSR control messages never loop because the master node never forwards them between its ring ports.

Note that the Hello Sequence number increments from the number it was before the primary port went down, because the master node could not transmit Health messages while the port was down.

This is equivalent to the packet shown in step 8 on page 38 of the master node debug output.

```
10:47:28 EPSR[1284]: EPSR: port1.0.1 Rx:
10:47:28 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:47:28 EPSR[1284]: EPSR:  00bb0100 00542188 00000000 0000cd24 0331990b 00400105
10:47:28 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00010002 0200054e 00000000
10:47:28 EPSR[1284]: EPSR: port1.0.1 Rx:
10:47:28 EPSR[1284]: EPSR: ------------------------------------------------------------------
10:47:28 EPSR[1284]: EPSR:           TYPE = HEALTH                         STATE = FAILED
10:47:28 EPSR[1284]: EPSR:      CTRL VLAN = 1000                          SYSTEM = 00-00-cd-24-03-31
10:47:28 EPSR[1284]: EPSR:     HELLO TIME = 1                          FAIL TIME = 2
10:47:28 EPSR[1284]: EPSR:      HELLO SEQ = 1358
10:47:28 EPSR[1284]: EPSR: ------------------------------------------------------------------
```

6. Transit node receives a Ring-Up-Flush-FDB message.

The Health message from the previous step reaches the master node and shows it that all links in the ring are now up. The master node sends a Ring-Up-Flush-FDB message. When it receives the message, the transit node unblocks port1.0.1 for vlan2, flushes its FDB, sends a trap, and changes the state to Link-Up.

This is equivalent to the packet shown in step 10 on page 39 of the master node debug output.

```
10:47:28 EPSR[1284]: EPSR: port1.0.1 Rx:
10:47:28 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:47:28 EPSR[1284]: EPSR:  00bb0100 005427d8 00000000 0000cd24 0331990b 00400106
10:47:28 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00000000 01000000 00000000
10:47:28 EPSR[1284]: EPSR: port1.0.1 Rx:
10:47:28 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:47:28 EPSR[1284]: EPSR:           TYPE = RING-UP-FLUSH-FDB         STATE = COMPLETE
10:47:28 EPSR[1284]: EPSR:      CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-03-31
10:47:28 EPSR[1284]: EPSR:     HELLO TIME = 0                     FAIL TIME = 0
10:47:28 EPSR[1284]: EPSR:      HELLO SEQ = 0
10:47:28 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:47:28 EPSR[1284]: EPSR: Unblock EPSR:awplus port:5001 VLAN:2
10:47:28 EPSR[1284]: EPSR: EPSR awplus: port 5001 is forwarding
10:47:28 EPSR[1284]: EPSR: Flush FDB EPSR: awplus  vid: 2
10:47:28 EPSR[1284]: EPSR: awplus oldState:PRE-FORWARDING newState:LINK-UP
```

7. The transit node receives Health messages

The transit node continues receiving Health messages for as long as the ring stays in a state of Complete.

These packets are equivalent to the packets shown in step 12 on page 40 of the master node debug output.

```
10:47:29 EPSR[1284]: EPSR: port1.0.1 Rx:
10:47:29 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:47:29 EPSR[1284]: EPSR:  00bb0100 00542287 00000000 0000cd24 0331990b 00400105
10:47:29 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00010002 0100054f 00000000
10:47:29 EPSR[1284]: EPSR: port1.0.1 Rx:
10:47:29 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:47:29 EPSR[1284]: EPSR:          TYPE = HEALTH                        STATE = COMPLETE
10:47:29 EPSR[1284]: EPSR:     CTRL VLAN = 1000                         SYSTEM = 00-00-cd-24-03-31
10:47:29 EPSR[1284]: EPSR:    HELLO TIME = 1                         FAIL TIME = 2
10:47:29 EPSR[1284]: EPSR:     HELLO SEQ = 1359
10:47:29 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:47:30 EPSR[1284]: EPSR: port1.0.1 Rx:
10:47:30 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:47:30 EPSR[1284]: EPSR:  00bb0100 00542286 00000000 0000cd24 0331990b 00400105
10:47:30 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00010002 01000550 00000000
10:47:30 EPSR[1284]: EPSR: port1.0.1 Rx:
10:47:30 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:47:30 EPSR[1284]: EPSR:          TYPE = HEALTH                        STATE = COMPLETE
10:47:30 EPSR[1284]: EPSR:     CTRL VLAN = 1000                         SYSTEM = 00-00-cd-24-03-31
10:47:30 EPSR[1284]: EPSR:    HELLO TIME = 1                         FAIL TIME = 2
10:47:30 EPSR[1284]: EPSR:     HELLO SEQ = 1360
10:47:30 EPSR[1284]: EPSR: -----------------------------------------------------------------
 .
 .
 .
```

Link Down Between Two Transit Nodes

This section shows the debugging output when the link between transit node B and transit node C goes down and comes back up again. It shows the debugging output for a complete failure and recovery cycle:

- on the master node, and then
- on transit node B

Master Node (Node A) Debug Output

The following debugging output starts with the ring established and in a state of Complete.

1. The master node sends Health messages

Each time the Hello timer expires, the master node sends a Health message out its primary port (port1.0.1). As long as the ring is in a state of Complete, it receives each Health message again on its secondary port (port1.0.2).

```
10:52:14 EPSR[1283]: EPSR: epsrHelloTimeout: EPSR awplus Hello Timer expired
10:52:14 EPSR[1283]: EPSR: port1.0.1 Tx:
10:52:14 EPSR[1283]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
10:52:14 EPSR[1283]: EPSR:  00bb0100 005425a3 00000000 0000cd24 0331990b 00400105
10:52:14 EPSR[1283]: EPSR:  03e80000 00000000 cd240331 00010002 0100001d 00000000
10:52:14 EPSR[1283]: EPSR: port1.0.1 Tx:
10:52:14 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:52:14 EPSR[1283]: EPSR:          TYPE = HEALTH                         STATE = COMPLETE
10:52:14 EPSR[1283]: EPSR:     CTRL VLAN = 1000                          SYSTEM = 00-00-cd-24-03-31
10:52:14 EPSR[1283]: EPSR:    HELLO TIME = 1                          FAIL TIME = 2
10:52:14 EPSR[1283]: EPSR:     HELLO SEQ = 29
10:52:14 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:52:14 EPSR[1283]: EPSR: port1.0.2 Rx:
10:52:14 EPSR[1283]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:52:14 EPSR[1283]: EPSR:  00bb0100 005425a3 00000000 0000cd24 0331990b 00400105
10:52:14 EPSR[1283]: EPSR:  03e80000 00000000 cd240331 00010002 0100001d 00000000
10:52:14 EPSR[1283]: EPSR: port1.0.2 Rx:
10:52:14 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:52:14 EPSR[1283]: EPSR:          TYPE = HEALTH                         STATE = COMPLETE
10:52:14 EPSR[1283]: EPSR:     CTRL VLAN = 1000                          SYSTEM = 00-00-cd-24-03-31
10:52:14 EPSR[1283]: EPSR:    HELLO TIME = 1                          FAIL TIME = 2
10:52:14 EPSR[1283]: EPSR:     HELLO SEQ = 29
10:52:14 EPSR[1283]: EPSR: -----------------------------------------------------------------
```

2. The link between the two transit nodes goes down

When the link goes down, the master node transmits a Health message but does not receive it on its secondary port.

```
10:53:21 EPSR[1283]: EPSR: port1.0.1 Tx:
10:53:21 EPSR[1283]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
10:53:21 EPSR[1283]: EPSR:  00bb0100 00542560 00000000 0000cd24 0331990b 00400105
10:53:21 EPSR[1283]: EPSR:  03e80000 00000000 cd240331 00010002 01000060 00000000
10:53:21 EPSR[1283]: EPSR: port1.0.1 Tx:
10:53:21 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:53:21 EPSR[1283]: EPSR:          TYPE = HEALTH                       STATE = COMPLETE
10:53:21 EPSR[1283]: EPSR:     CTRL VLAN = 1000                        SYSTEM = 00-00-cd-24-03-31
10:53:21 EPSR[1283]: EPSR:    HELLO TIME = 1                        FAIL TIME = 2
10:53:21 EPSR[1283]: EPSR:     HELLO SEQ = 96
10:53:21 EPSR[1283]: EPSR: -----------------------------------------------------------------
```

3. The master node receives a Link-Down message on its secondary port

The master node receives a Link-Down message, which tells it that a link in the ring is broken. This message came from the transit node on one side of the broken link.

```
10:53:21 EPSR[1283]: EPSR: port1.0.2 Rx:
10:53:21 EPSR[1283]: EPSR:  00e02b00 00040000 cd127808 810003e8 0058aaaa 0300e02b
10:53:21 EPSR[1283]: EPSR:  00bb0100 00543935 00000000 0000cd12 7808990b 00400108
10:53:21 EPSR[1283]: EPSR:  03e80000 00000000 cd127808 00000000 04000000 00000000
10:53:21 EPSR[1283]: EPSR: port1.0.2 Rx:
10:53:21 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:53:21 EPSR[1283]: EPSR:          TYPE = LINK-DOWN                    STATE = LINK-DOWN
10:53:21 EPSR[1283]: EPSR:     CTRL VLAN = 1000                        SYSTEM = 00-00-cd-12-78-08
10:53:21 EPSR[1283]: EPSR:    HELLO TIME = 0                        FAIL TIME = 0
10:53:21 EPSR[1283]: EPSR:     HELLO SEQ = 0
10:53:21 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:53:21 EPSR[1283]: EPSR: EPSR awplus: link down msg from 00-00-cd-12-78-08
```

4. The master node transmits a Ring-Down-Flush-FDB message

In response to the Link-Down message, the master node transmits a Ring-Down-Flush-FDB message out both its primary and secondary ports. The message has to go out both ports to make sure it reaches the nodes on both sides of the broken link. The master node also unblocks its secondary port for vlan2, flushes its forwarding database, sends a trap, and changes the EPSR state to Failed.

```
10:53:21 EPSR[1283]: EPSR: port1.0.1 Tx:
10:53:21 EPSR[1283]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
10:53:21 EPSR[1283]: EPSR:  00bb0100 005424c1 00000000 0000cd24 0331990b 00400107
10:53:21 EPSR[1283]: EPSR:  03e80000 00000000 cd240331 00000000 02000000 00000000
10:53:21 EPSR[1283]: EPSR: port1.0.1 Tx:
10:53:21 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:53:21 EPSR[1283]: EPSR:           TYPE = RING-DOWN-FLUSH-FDB       STATE = FAILED
10:53:21 EPSR[1283]: EPSR:      CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-03-31
10:53:21 EPSR[1283]: EPSR:     HELLO TIME = 0                     FAIL TIME = 0
10:53:21 EPSR[1283]: EPSR:      HELLO SEQ = 0
10:53:21 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:53:21 EPSR[1283]: EPSR: port1.0.2 Tx:
10:53:21 EPSR[1283]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
10:53:21 EPSR[1283]: EPSR:  00bb0100 005424c1 00000000 0000cd24 0331990b 00400107
10:53:21 EPSR[1283]: EPSR:  03e80000 00000000 cd240331 00000000 02000000 00000000
10:53:21 EPSR[1283]: EPSR: port1.0.2 Tx:
10:53:21 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:53:21 EPSR[1283]: EPSR:           TYPE = RING-DOWN-FLUSH-FDB       STATE = FAILED
10:53:21 EPSR[1283]: EPSR:      CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-03-31
10:53:21 EPSR[1283]: EPSR:     HELLO TIME = 0                     FAIL TIME = 0
10:53:21 EPSR[1283]: EPSR:      HELLO SEQ = 0
10:53:21 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:53:21 EPSR[1283]: EPSR: Unblock EPSR:awplus port:5002 VLAN:2
10:53:21 EPSR[1283]: EPSR: EPSR awplus: port 5002 is forwarding
10:53:21 EPSR[1283]: EPSR: Flush FDB EPSR: awplus  vid: 2
10:53:21 EPSR[1283]: EPSR: awplus oldState:COMPLETE newState:FAILED
```

5. The master node receives a second Link-Down message

The master node receives a Link-Down message from the transit node on the other side of the broken link. This message arrived after a delay because the ring ports are 1000M ports (see "Ports and Recovery Times" on page 29). The master node does not take any action in response to this message, because it already responded to the broken link.

```
10:53:21 EPSR[1283]: EPSR: port1.0.1 Rx:
10:53:21 EPSR[1283]: EPSR:  00e02b00 00040000 cd240226 810003e8 0058aaaa 0300e02b
10:53:21 EPSR[1283]: EPSR:  00bb0100 005424d6 00000000 0000cd24 0226990b 00400108
10:53:21 EPSR[1283]: EPSR:  03e80000 00000000 cd240226 00000000 04000000 00000000
10:53:21 EPSR[1283]: EPSR: port1.0.1 Rx:
10:53:21 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:53:21 EPSR[1283]: EPSR:           TYPE = LINK-DOWN                 STATE = LINK-DOWN
10:53:21 EPSR[1283]: EPSR:      CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-02-26
10:53:21 EPSR[1283]: EPSR:     HELLO TIME = 0                     FAIL TIME = 0
10:53:21 EPSR[1283]: EPSR:      HELLO SEQ = 0
10:53:21 EPSR[1283]: EPSR: -----------------------------------------------------------------
```

6. The master node continues sending Health messages

The master node continues sending Health messages out its primary port. It does not receive any of these at the secondary port, which tells it that the link is still down.

```
10:53:22 EPSR[1283]: EPSR: port1.0.1 Tx:
10:53:22 EPSR[1283]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
10:53:22 EPSR[1283]: EPSR:  00bb0100 0054245f 00000000 0000cd24 0331990b 00400105
10:53:22 EPSR[1283]: EPSR:  03e80000 00000000 cd240331 00010002 02000061 00000000
10:53:22 EPSR[1283]: EPSR: port1.0.1 Tx:
10:53:22 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:53:22 EPSR[1283]: EPSR:          TYPE = HEALTH                     STATE = FAILED
10:53:22 EPSR[1283]: EPSR:     CTRL VLAN = 1000                      SYSTEM = 00-00-cd-24-03-31
10:53:22 EPSR[1283]: EPSR:    HELLO TIME = 1                      FAIL TIME = 2
10:53:22 EPSR[1283]: EPSR:     HELLO SEQ = 97
10:53:22 EPSR[1283]: EPSR: -----------------------------------------------------------------
 .
 .
 .
```

7. The master node receives a Health message

The master node transmits a Health message and receives it at the secondary port. This indicates that the link is back up.

```
10:59:12 EPSR[1283]: EPSR: port1.0.1 Tx:
10:59:12 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:59:12 EPSR[1283]: EPSR:          TYPE = HEALTH                     STATE = FAILED
10:59:12 EPSR[1283]: EPSR:     CTRL VLAN = 1000                      SYSTEM = 00-00-cd-24-03-31
10:59:12 EPSR[1283]: EPSR:    HELLO TIME = 1                      FAIL TIME = 2
10:59:12 EPSR[1283]: EPSR:     HELLO SEQ = 447
10:59:12 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:59:12 EPSR[1283]: EPSR: port1.0.2 Rx:
10:59:12 EPSR[1283]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:59:12 EPSR[1283]: EPSR:  00bb0100 00542301 00000000 0000cd24 0331990b 00400105
10:59:12 EPSR[1283]: EPSR:  03e80000 00000000 cd240331 00010002 020001bf 00000000
10:59:12 EPSR[1283]: EPSR: port1.0.2 Rx:
10:59:12 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:59:12 EPSR[1283]: EPSR:          TYPE = HEALTH                     STATE = FAILED
10:59:12 EPSR[1283]: EPSR:     CTRL VLAN = 1000                      SYSTEM = 00-00-cd-24-03-31
10:59:12 EPSR[1283]: EPSR:    HELLO TIME = 1                      FAIL TIME = 2
10:59:12 EPSR[1283]: EPSR:     HELLO SEQ = 447
10:59:12 EPSR[1283]: EPSR: -----------------------------------------------------------------
```

8. The master node returns the ring to a state of Complete

Now that the ring is back up, the master node blocks its secondary port for the data VLAN, transmits a Ring-Up-Flush-FDB message, flushes its FDB, sends a trap, and changes the EPSR state to Complete.

```
10:59:12 EPSR[1283]: EPSR: Block EPSR:awplus port:5002 VLAN:2
10:59:12 EPSR[1283]: EPSR: EPSR awplus: port 5002 is blocking
10:59:12 EPSR[1283]: EPSR: port1.0.1 Tx:
10:59:12 EPSR[1283]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
10:59:12 EPSR[1283]: EPSR:  00bb0100 005425c2 00000000 0000cd24 0331990b 00400106
10:59:12 EPSR[1283]: EPSR:  03e80000 00000000 cd240331 00000000 01000000 00000000
10:59:12 EPSR[1283]: EPSR: port1.0.1 Tx:
10:59:12 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:59:12 EPSR[1283]: EPSR:           TYPE = RING-UP-FLUSH-FDB         STATE = COMPLETE
10:59:12 EPSR[1283]: EPSR:      CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-03-31
10:59:12 EPSR[1283]: EPSR:     HELLO TIME = 0                     FAIL TIME = 0
10:59:12 EPSR[1283]: EPSR:      HELLO SEQ = 0
10:59:12 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:59:12 EPSR[1283]: EPSR: Flush FDB EPSR: awplus  vid: 2
10:59:12 EPSR[1283]: EPSR: awplus oldState:FAILED newState:COMPLETE
10:59:12 EPSR[1283]: EPSR: EPSR awplus: ring complete
```

9. The master node receives the Ring-Up-Flush-FDB message on port1.0.2

The master node receives the Ring-Up-Flush-FDB message back on its secondary port, because the packet traversed the whole ring. The master node ignores the message.

```
10:59:12 EPSR[1283]: EPSR: port1.0.2 Rx:
10:59:12 EPSR[1283]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:59:12 EPSR[1283]: EPSR:  00bb0100 005425c2 00000000 0000cd24 0331990b 00400106
10:59:12 EPSR[1283]: EPSR:  03e80000 00000000 cd240331 00000000 01000000 00000000
10:59:12 EPSR[1283]: EPSR: port1.0.2 Rx:
10:59:12 EPSR[1283]: EPSR: -----------------------------------------------------------------
10:59:12 EPSR[1283]: EPSR:           TYPE = RING-UP-FLUSH-FDB         STATE = COMPLETE
10:59:12 EPSR[1283]: EPSR:      CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-03-31
10:59:12 EPSR[1283]: EPSR:     HELLO TIME = 0                     FAIL TIME = 0
10:59:12 EPSR[1283]: EPSR:      HELLO SEQ = 0
10:59:12 EPSR[1283]: EPSR: -----------------------------------------------------------------
```

10. The master node transmits and receives Health messages

The master node continues transmitting and receiving Health messages for as long as the ring stays in a state of Complete.

```
10:59:13 EPSR[1283]: EPSR: port1.0.1 Tx:
10:59:13 EPSR[1283]: EPSR:  00e02b00 00040000 cd240331 8100e3e8 005caaaa 0300e02b
10:59:13 EPSR[1283]: EPSR:  00bb0100 00542400 00000000 0000cd24 0331990b 00400105
10:59:13 EPSR[1283]: EPSR:  03e80000 00000000 cd240331 00010002 010001c0 00000000
10:59:13 EPSR[1283]: EPSR: port1.0.1 Tx:
10:59:13 EPSR[1283]: EPSR: ------------------------------------------------------------------
10:59:13 EPSR[1283]: EPSR:          TYPE = HEALTH                    STATE = COMPLETE
10:59:13 EPSR[1283]: EPSR:     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-03-31
10:59:13 EPSR[1283]: EPSR:    HELLO TIME = 1                     FAIL TIME = 2
10:59:13 EPSR[1283]: EPSR:     HELLO SEQ = 448
10:59:13 EPSR[1283]: EPSR: ------------------------------------------------------------------
10:59:13 EPSR[1283]: EPSR: port1.0.2 Rx:
10:59:13 EPSR[1283]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:59:13 EPSR[1283]: EPSR:  00bb0100 00542400 00000000 0000cd24 0331990b 00400105
10:59:13 EPSR[1283]: EPSR:  03e80000 00000000 cd240331 00010002 010001c0 00000000
10:59:13 EPSR[1283]: EPSR: port1.0.2 Rx:
10:59:13 EPSR[1283]: EPSR: ------------------------------------------------------------------
10:59:13 EPSR[1283]: EPSR:          TYPE = HEALTH                    STATE = COMPLETE
10:59:13 EPSR[1283]: EPSR:     CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-03-31
10:59:13 EPSR[1283]: EPSR:    HELLO TIME = 1                     FAIL TIME = 2
10:59:13 EPSR[1283]: EPSR:     HELLO SEQ = 448
10:59:13 EPSR[1283]: EPSR: ------------------------------------------------------------------
   .
   .
   .
```

Transit Node (Node B) Debug Output

The following debugging shows the same sequence of events as the previous section, but on the transit node instead of the master node. It starts with the ring established and in a state of Complete.

Note that the following debug was captured at a different time (during a different ring-down event) from the master node debug in the previous section. This is why the times and hello sequence numbers do not match.

1. The transit node receives Health messages

The transit node receives Health messages on port1.0.1, because that port is connected to the master node's primary port. Note that the message shows that the ring state is Complete.

Also note the hello sequence number, which is very close to the maximum of 65535. Once the number reaches 65535, it restarts at zero.

These packets are equivalent to the packets shown in step 1 on page 46 of the master node debug output.

```
10:23:12 EPSR[1284]: EPSR: port1.0.1 Rx:
10:23:12 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:23:12 EPSR[1284]: EPSR:  00bb0100 005427e9 00000000 0000cd24 0331990b 00400105
10:23:12 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00010002 0100ffec 00000000
10:23:12 EPSR[1284]: EPSR: port1.0.1 Rx:
10:23:12 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:23:12 EPSR[1284]: EPSR:          TYPE = HEALTH                        STATE = COMPLETE
10:23:12 EPSR[1284]: EPSR:     CTRL VLAN = 1000                         SYSTEM = 00-00-cd-24-03-31
10:23:12 EPSR[1284]: EPSR:    HELLO TIME = 1                         FAIL TIME = 2
10:23:12 EPSR[1284]: EPSR:     HELLO SEQ = 65516
10:23:12 EPSR[1284]: EPSR: -----------------------------------------------------------------
 .
 .
 .
```

2. The link between the two transit nodes goes down

The transit node receives Health message 29. At this stage, the message does not indicate that anything is wrong. However, between messages 28 and 29, the link went down. This means that message 29 will not make it back to the master node.

Note that the hello sequence counter has wrapped and is now counting up from zero.

This packet is equivalent to the packet shown in step 2 on page 47 of the master node debug output.

```
10:24:01 EPSR[1284]: EPSR: port1.0.1 Rx:
10:24:01 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:24:01 EPSR[1284]: EPSR:  00bb0100 005427b9 00000000 0000cd24 0331990b 00400105
10:24:01 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00010002 0100001d 00000000
10:24:01 EPSR[1284]: EPSR: port1.0.1 Rx:
10:24:01 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:24:01 EPSR[1284]: EPSR:          TYPE = HEALTH                          STATE = COMPLETE
10:24:01 EPSR[1284]: EPSR:     CTRL VLAN = 1000                           SYSTEM = 00-00-cd-24-03-31
10:24:01 EPSR[1284]: EPSR:    HELLO TIME = 1                           FAIL TIME = 2
10:24:01 EPSR[1284]: EPSR:     HELLO SEQ = 29
10:24:01 EPSR[1284]: EPSR: -----------------------------------------------------------------
```

3. The transit node receives a Ring-Down-Flush-FDB message

In the meanwhile, the master node has received a Link-Down message from the switch at the other end of the broken link (in step 3 on page 47). Therefore, the master node realises that the ring is broken and acts accordingly. As part of the recovery process, the master node sends a Ring-Down-Flush-FDB message. The transit node receives this message and flushes its forwarding database.

This packet is equivalent to the packet shown in step 4 on page 48 of the master node debug output.

```
10:24:02 EPSR[1284]: EPSR: port1.0.1 Rx:
10:24:02 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:24:02 EPSR[1284]: EPSR:  00bb0100 005426d7 00000000 0000cd24 0331990b 00400107
10:24:02 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00000000 02000000 00000000
10:24:02 EPSR[1284]: EPSR: port1.0.1 Rx:
10:24:02 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:24:02 EPSR[1284]: EPSR:          TYPE = RING-DOWN-FLUSH-FDB             STATE = FAILED
10:24:02 EPSR[1284]: EPSR:     CTRL VLAN = 1000                           SYSTEM = 00-00-cd-24-03-31
10:24:02 EPSR[1284]: EPSR:    HELLO TIME = 0                           FAIL TIME = 0
10:24:02 EPSR[1284]: EPSR:     HELLO SEQ = 0
10:24:02 EPSR[1284]: EPSR: -----------------------------------------------------------------
```

4. The transit node sends a Link-Down message

The transit node realises that its port is down, sends a Link-Down message, sends a trap, and changes its state to Link-Down. The transit node sends this message some time after the link actually went down, because the ring ports are 1000M ports (see "Ports and Recovery Times" on page 29). Note that by this stage the ring has already changed topology to restore traffic flow. The master node detected the link failure by receiving a Link-Down message from the other side of the link.

This is equivalent to the Link-Down message that the master switch received in step 5 on page 48.

```
10:24:02 EPSR[1284]: EPSR: port1.0.1 Tx:
10:24:02 EPSR[1284]: EPSR:  00e02b00 00040000 cd240226 8100e3e8 005caaaa 0300e02b
10:24:02 EPSR[1284]: EPSR:  00bb0100 005422c0 00000000 0000cd24 0226990b 00400108
10:24:02 EPSR[1284]: EPSR:  03e80000 00000000 cd240226 00000000 04000000 00000000
10:24:02 EPSR[1284]: EPSR: port1.0.1 Tx:
10:24:02 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:24:02 EPSR[1284]: EPSR:           TYPE = LINK-DOWN                  STATE = LINK-DOWN
10:24:02 EPSR[1284]: EPSR:      CTRL VLAN = 1000                      SYSTEM = 00-00-cd-24-02-26
10:24:02 EPSR[1284]: EPSR:     HELLO TIME = 0                      FAIL TIME = 0
10:24:02 EPSR[1284]: EPSR:      HELLO SEQ = 0
10:24:02 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:24:02 EPSR[1284]: EPSR: awplus oldState:LINK-UP newState:LINK-DOWN
```

5. The transit node receives Health messages

The transit node receives Health messages from the master node. These have a state of Failed, which shows that the ring is still broken.

This packet is equivalent to the packet shown in step 6 on page 49 of the master node debug output.

```
10:24:02 EPSR[1284]: EPSR: port1.0.1 Rx:
10:24:02 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:24:02 EPSR[1284]: EPSR:  00bb0100 005426b8 00000000 0000cd24 0331990b 00400105
10:24:02 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00010002 0200001e 00000000
10:24:02 EPSR[1284]: EPSR: port1.0.1 Rx:
10:24:02 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:24:02 EPSR[1284]: EPSR:           TYPE = HEALTH                     STATE = FAILED
10:24:02 EPSR[1284]: EPSR:      CTRL VLAN = 1000                      SYSTEM = 00-00-cd-24-03-31
10:24:02 EPSR[1284]: EPSR:     HELLO TIME = 1                      FAIL TIME = 2
10:24:02 EPSR[1284]: EPSR:      HELLO SEQ = 30
10:24:02 EPSR[1284]: EPSR: -----------------------------------------------------------------
  .
  .
  .
```

6. The link comes back up

The transit node detects that the broken link has come back up. It blocks the port to prevent a loop from occurring, sends a trap, and changes the EPSR state to Pre-forwarding.

```
10:42:49 EPSR[1284]: EPSR: Block EPSR:awplus port:5002 VLAN:2
10:42:49 EPSR[1284]: EPSR: EPSR awplus: port 5002 is blocking
10:42:49 EPSR[1284]: EPSR: EPSR awplus, ifIndex 5002 up
10:42:49 EPSR[1284]: EPSR: awplus oldState:LINK-DOWN newState:PRE-FORWARDING
```

7. The transit node receives another Health message

The transit node receives another Health message. This message will make it back to the master node's secondary port, because the link between the two transit nodes is now up.

This packet is equivalent to the packet shown in step 7 on page 49 of the master node debug output.

```
10:42:50 EPSR[1284]: EPSR: port1.0.1 Rx:
10:42:50 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:42:50 EPSR[1284]: EPSR:  00bb0100 00542251 00000000 0000cd24 0331990b 00400105
10:42:50 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00010002 02000485 00000000
10:42:50 EPSR[1284]: EPSR: port1.0.1 Rx:
10:42:50 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:42:50 EPSR[1284]: EPSR:           TYPE = HEALTH                       STATE = FAILED
10:42:50 EPSR[1284]: EPSR:      CTRL VLAN = 1000                        SYSTEM = 00-00-cd-24-03-31
10:42:50 EPSR[1284]: EPSR:     HELLO TIME = 1                        FAIL TIME = 2
10:42:50 EPSR[1284]: EPSR:      HELLO SEQ = 1157
10:42:50 EPSR[1284]: EPSR: -----------------------------------------------------------------
```

8. The transit node receives a Ring-Up-Flush-FDB message

The transit node receives a Ring-Up-Flush-FDB message, which indicates that the master node knows that all links in the ring are up again. The transit node unblocks port1.0.2 for vlan2, flushes its FDB, sends a trap, and changes state to Link-Up.

This packet is equivalent to the packet shown in step 8 on page 50 of the master node debug output.

```
10:42:50 EPSR[1284]: EPSR: port1.0.1 Rx:
10:42:50 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:42:50 EPSR[1284]: EPSR:  00bb0100 005427d8 00000000 0000cd24 0331990b 00400106
10:42:50 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00000000 01000000 00000000
10:42:50 EPSR[1284]: EPSR: port1.0.1 Rx:
10:42:50 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:42:50 EPSR[1284]: EPSR:           TYPE = RING-UP-FLUSH-FDB         STATE = COMPLETE
10:42:50 EPSR[1284]: EPSR:      CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-03-31
10:42:50 EPSR[1284]: EPSR:     HELLO TIME = 0                     FAIL TIME = 0
10:42:50 EPSR[1284]: EPSR:      HELLO SEQ = 0
10:42:50 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:42:50 EPSR[1284]: EPSR: Unblock EPSR:awplus port:5002 VLAN:2
10:42:50 EPSR[1284]: EPSR: EPSR awplus: port 5002 is forwarding
10:42:50 EPSR[1284]: EPSR: Flush FDB EPSR: awplus  vid: 2
10:42:50 EPSR[1284]: EPSR: awplus oldState:PRE-FORWARDING newState:LINK-UP
```

9. The transit node receives Health messages

The transit node continues receiving Health messages for as long as the ring stays in a state of Complete.

This is equivalent to the packet shown in step 10 on page 51 of the master node debug output.

```
10:42:51 EPSR[1284]: EPSR: port1.0.1 Rx:
10:42:51 EPSR[1284]: EPSR:  00e02b00 00040000 cd240331 810003e8 0058aaaa 0300e02b
10:42:51 EPSR[1284]: EPSR:  00bb0100 00542350 00000000 0000cd24 0331990b 00400105
10:42:51 EPSR[1284]: EPSR:  03e80000 00000000 cd240331 00010002 01000486 00000000
10:42:51 EPSR[1284]: EPSR: port1.0.1 Rx:
10:42:51 EPSR[1284]: EPSR: -----------------------------------------------------------------
10:42:51 EPSR[1284]: EPSR:           TYPE = HEALTH                    STATE = COMPLETE
10:42:51 EPSR[1284]: EPSR:      CTRL VLAN = 1000                     SYSTEM = 00-00-cd-24-03-31
10:42:51 EPSR[1284]: EPSR:     HELLO TIME = 1                     FAIL TIME = 2
10:42:51 EPSR[1284]: EPSR:      HELLO SEQ = 1158
10:42:51 EPSR[1284]: EPSR: -----------------------------------------------------------------
 .
 .
 .
```

USA Headquarters | 19800 North Creek Parkway | Suite 100 | Bothell | WA 98011 | USA | T: +1 800 424 4284 | F: +1 425 481 3895
European Headquarters | Via Motta 24 | 6830 Chiasso | Switzerland | T: +41 91 69769.00 | F: +41 91 69769.11
Asia-Pacific Headquarters | 11 Tai Seng Link | Singapore | 534182 | T: +65 6383 3832 | F: +65 6383 3830
www.alliedtelesis.com

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