G.8032 and CFM Support for Microwave Adaptive Bandwidth

The G.8032 and CFM Support for Microwave Adaptive Bandwidth feature enables the G.8032 Ethernet Protection Ring (ERP) mechanism to be used as a trigger in response to bandwidth degradation occurrences (such as a signal degradation [SD] indicator) on microwave links. Ethernet Connectivity Fault Management (CFM) interacts with the microwave transceiver to continuously check the quality and the bandwidth of the microwave link. When microwave link degradation (based on the configured service level agreement [SLA] in use) is detected, CFM notifies the Embedded Event Manager (EEM), which in turn notifies a mechanism such as, G.8032 ERP. G.8032 ERP ensures that the degraded microwave link is bypassed and no longer used. The degraded microwave link can still be used by one or more of the G.8032 ERP instances. Only the affected G.8032 ERP instances are switched to alternate link.

Prerequisites for G.8032 and CFM Microwave Adaptive Bandwidth Support

- The microwave transceiver in the network topology must support adaptive bandwidth modulation, and the microwave transceiver must support the Ethernet Connectivity Fault Management (CFM) extension for microwave devices as defined by Cisco.

- All devices connected directly to the microwave transceiver must support signal degradation (SD) functions. Devices not connected directly to the microwave transceiver can be standard-compliant nodes or enhanced SD-capable nodes.

- In any homogeneous ring topology, all links must be microwave links and all devices must support microwave SD-based ring protection.

- A ring topology with multiple microwave links can experience a signal degradation condition on one or more of the microwave links. Only one signal degradation condition per ring instance is supported. This support is provided on a first-come, first-serve basis, per ring instance.

About G.8032 and CFM Support for Microwave Adaptive Bandwidth

Microwave Adaptive Bandwidth Feature Functionality

The G.8032 and CFM Support for Microwave Adaptive Bandwidth feature extends the functionality of the G.8032 Ethernet Protection Ring (ERP) mechanism and Ethernet Connectivity Fault Management (CFM).

This feature enables the G.8032 ERP mechanism to be used as a trigger in response to bandwidth degradation occurrences (such as a signal degradation [SD] indicator) on microwave links. Ethernet CFM interacts with the microwave transceiver to continuously check the quality and the bandwidth of the microwave link. When microwave link degradation (based on the configured service level agreement [SLA] in use) is detected, CFM notifies the Embedded Event Manager (EEM), which in turn notifies a mechanism such as, G.8032 ERP. G.8032 ERP ensures that the degraded microwave link is bypassed and no longer used. Depending upon the severity of the signal degradation and the configured threshold, G.8032 protection switching occurs on a per-instance basis.

For more information about Ethernet CFM, see the "Configuring IEEE Standard-Compliant Ethernet CFM in a Service Provider Network" module or the "Configuring Ethernet Connectivity Fault Management in a Service Provider Network" module.

For more information about G.8032 ERP, see the "ITU-T G.8032 Ethernet Ring Protection Switching" module.

Fixed Versus Adaptive Bandwidth Modulation and the Microwave Adaptive Bandwidth Feature

Traditional microwave radios use fixed modulation schemes whereby any degradation in the wave propagation conditions (for example, due to adverse weather conditions such as heavy fog or rain) led to complete loss of the signal and a disruption of traffic. In a fixed modulation scheme, the microwave radio link had a binary state of either "available" (on) or "unavailable" (off).

More technologically advanced microwave radios use an adaptive modulation scheme. In an adaptive modulation scheme, when the microwave link degrades due to adverse weather conditions, the radio changes its modulation scheme to a more robust scheme. The radio continues to broadcast but with less capacity. As a result, the radio can be in several capacity or bandwidth states, and not just on or off.

In the case of microwave links with adaptive modulation, the control Operation, Administration, and Maintenance (OAM) protocols are unable to make best use of the available bandwidth due of the following OAM characteristics:

• If the protocol used for failure detection is tagged as high-priority traffic, the OAM frames bypass the degraded (congested) microwave links and no protection switching is triggered.

• If the protocol used for failure detection is tagged as low-priority traffic, then momentary congestion over the native Ethernet (that is, the nonmicrowave) links could lead to loss of continuity and spurious protection switching.

Even though the network topology must be provisioned with enough redundant bandwidth to handle a complete failure, in certain situations where the service committed information rate (CIR) is very low, forwarding as

much excess traffic (above the CIR) as possible is important. Therefore, for those situations, treating bandwidth degradation as a complete failure is not desirable.

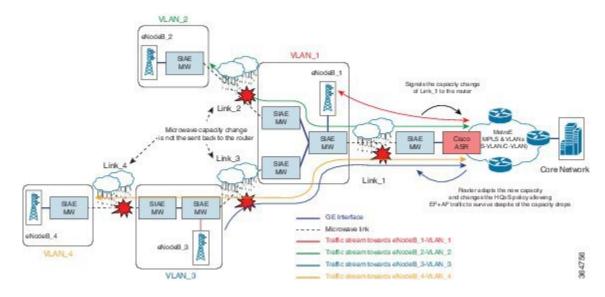# Adaptive Bandwidth Multi-hop Extensions

In a network topology consider a single interface on the head-end router is connected to a topology consisting of multiple microwave links either in series or in a hub-and-spoke arrangement. In such scenarios, the links degrade independently, and send their own VSMs containing current and nominal bandwidth for their links. Identifying the VSMs with the source MAC address does not help identify the degraded link.

To help identify the degraded links in a multi-hop topology, Link IDs can be configured on the VSM. The Link ID is configured in the EEM configuration using the **event ethernet microwave sd interface** command. The command support registrations on one or more individual links identified by either link ID or source MAC address.

With multi-hop topology, all individual links identified by the interface. If the interface is degraded, the links too get degraded.

The multi-hop topology is supported when multiple microwave links are grouped together into a port-channel.

Figure 1: Adaptive Bandwidth with Multi-hop Extensions

Prerequisites for Assigning Link IDs

- If VSMs for multiple links are sent from the same source MAC address, then link IDs must be used.

- Link IDs must be unique within the network segment connected to a single physical link on the head-end router.

Restrictions for Assigning Link IDs

- If link IDs are used, the EEM scripts are registered on either a set of source MAC addresses or a set of link IDs but not a mixture of both.

- When registering an EEM script and specifying multiple links it is recommended that the threshold is equal to or lower than the minimum nominal bandwidth across all those links.

How to Configure G.8032 and CFM Support for Microwave Adaptive Bandwidth

Creating the Ethernet Microwave Event and Using G.8032 to Specify Appropriate Actions

For more information on how to configure the ethernet ring profile, see LAN Switching Configuration Guide IOS XE Release 3S (Cisco ASR 900 Series).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **event manager applet** *applet-name*
4. **event ethernet microwave sd** {**interface** *type number* [**mac-address** *mac_address* | **link-id** *link-id*]**threshold** *threshold-bandwidth*}
5. **action** *action-id* **switch ring g8032** *ring-name* **instance** *instance-id*
6. **event ethernet microwave clear-sd** {**interface** *type number*}
7. **action** *action-id* **switch ring g8032 clear** *ring-name* **instance** {*instance-id* | **all**}
8. Repeat steps 4 through 7 for each Ethernet microwave event you want to create. Then proceed to step 9.
9. **exit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**event manager applet** *applet-name* **Example:** `Device(config)# event manager applet mw_ring_sd1`	Registers an applet with the Embedded Event Manager (EEM) and enters applet configuration mode.

	Command or Action	Purpose
Step 4	**event ethernet microwave sd** {**interface** *type number* [**mac-address** *mac_address*	**link-id** *link-id*]**threshold** *threshold-bandwidth*} **Example:** `Device(config-applet)# event ethernet microwave sd interface gigabitethernet0/0/0 link-id 23 threshold 400`	Creates the Ethernet microwave signal degradation (SD) event. • **mac-address** *mac_address*	**link-id** *link-id* Optional—Specifies one or more links for monitoring. Either the MAC address or the link ID can be specified. • After the event is created, use the **action switch ring g8032 instance** command at step 5 to specify the appropriate action to take on this event.
Step 5	**action** *action-id* **switch ring g8032** *ring-name* **instance** *instance-id* **Example:** `Device(config-applet)# action 1 switch ring g8032 ringA instance 1`	Specifies the protocol switch action for an instance on a link of a G.8032 Ethernet Protection Ring (ERP).
Step 6	**event ethernet microwave clear-sd** {**interface** *type number*} **Example:** `Device(config-applet)# event ethernet microwave clear-sd interface gigabitethernet0/0/0`	Creates the Ethernet microwave event to be associated with bandwidth SD occurrences. • After the event is created, use the **action switch ring g8032 clear instance** command at step 7 to clear the SD occurrence and bring the ring back to the normal (idle) state.
Step 7	**action** *action-id* **switch ring g8032 clear** *ring-name* **instance** {*instance-id*	**all**} **Example:** `Device(config-applet)# action 1 switch ring g8032 clear ringA instance 1`	Specifies the action of clearing an SD occurrence on a link of a G.8032 Ethernet Protection Ring (ERP) topology.
Step 8	Repeat steps 4 through 7 for each Ethernet microwave event you want to create. Then proceed to step 9. **Example:** _	
Step 9	**exit** **Example:** `Device(config-applet)# exit`	Exits applet configuration mode.

Modifying Ethernet Microwave Event Settings

SUMMARY STEPS

1.   **enable**

2. **configure   terminal**
3. **interface** *type name*
4. **ethernet event microwave hold-off** *seconds*
5. **ethernet event microwave loss-threshold** *number-of-messages*
6. **ethernet event microwave wtr** *seconds*
7. **exit**
8. **show ethernet event microwave status** [**interface** *type number*]
9. **show ethernet event microwave statistics** [**interface** *type number*]
10. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type name* **Example:** `Device(config)# interface gigabitethernet0/0/0`	Specifies an interface and enters interface configuration mode.
Step 4	**ethernet event microwave hold-off** *seconds* **Example:** `Device(config-if)# ethernet event microwave hold-off 30`	Specifies the microwave bandwidth degradation hold-off time, in seconds. • This time is used to prevent changes in the state of the network node as a result of signal degradation (SD) occurrences.
Step 5	**ethernet event microwave loss-threshold** *number-of-messages* **Example:** `Device(config-if)# ethernet event microwave loss-threshold 3`	Specifies the number of bandwidth Vendor-Specific Messages (VSM) sent from the microwave transceiver to the Cisco device. Once the link experiences signal degradation, the microwave transceiver sends periodic bandwidth VSM messages to the Cisco device until the bandwidth is fully restored. The interval of these messages is controlled by the microwave transceiver. This configuration specifies the continuous bandwidth VSM messages the Cisco device misses before declaring a signal recovery event.

	Command or Action	Purpose
		Note The signal degradation event is generated if any of these becomes degraded: • Different link IDs • Source MACs
Step 6	**ethernet event microwave wtr** *seconds* **Example:** Device(config-if)# ethernet event microwave wtr 45	Specifies the wait-to-restore (WTR) time, in seconds. • This time is used to prevent changes in the state of the network node as a result of recovery events after an SD occurrence. **Note** Timer parameters are applicable to Port-channel.
Step 7	**exit** **Example:** Device(config-if)# exit	Exits interface configuration mode.
Step 8	**show ethernet event microwave status** [**interface** *type number*] **Example:** Device# show ethernet event microwave status GigabitEthernet 0/0/2	(Optional) Displays the microwave event status.
Step 9	**show ethernet event microwave statistics** [**interface** *type number*] **Example:** Device# show ethernet event microwave statistics GigabitEthernet 0/0/2	(Optional) Displays the microwave event statistics.
Step 10	**end** **Example:** Device# end	Returns to user EXEC mode.

Configuration Examples for G.8032 and CFM Support for Microwave Adaptive Bandwidth

Example: Configuring the Ethernet Microwave Event

In this example, two Ethernet microwave events have been created, mw_ring_sdl1 and mw_ring_sd_2:

```
Device> enable
Device> configure terminal
Device(config)# event manager applet mw_ring_sd1
Device(config-applet)# event ethernet microwave sd interface gigabitethernet0/0/0 threshold
 400
Device(config-applet)# action 1 switch ring g8032 ringA instance 1
Device(config-applet)# exit
Device(config)# event manager applet mw_ring_sd2
Device(config-applet)# event ethernet microwave sd interface gigabitethernet0/0/0 threshold
 400
Device(config-applet)# action 1 switch ring g8032 ringA instance 2
Device(config-applet)# exit
```

In this example, a microwave event has been configured that clears all the signal degradation (SD) events, as defined by the **action switch ring g8032 clear instance all** command:

```
Device> enable
Device> configure terminal
Device(config)# event manager applet mw_ring_clear_sd
Device(config-applet)# event ethernet microwave clear-sd interface gigabitethernet0/0/0
Device(config-applet)# action 1 switch ring g8032 clear ringA instance all
Device(config-applet)# exit
```

Example: Verifying the Ethernet Microwave Event Configuration

The following is sample output from the **show ethernet event microwave status** command where GigabitEthernet interface 0/0/2 has been specified. Use the command to confirm that the configuration is performing as intended.

```
Device# show ethernet event microwave status GigabitEthernet 0/0/2

Microwave Bandwidth Status for GigabitEthernet0/0/2
State: SIGNAL_DEGRADED
Hold Time: 0 seconds
Restore Time: 10 seconds
Loss Threshold: 3
Total VSM Receive Count: 1
Total VSM Drop Count: 0

Sender Address 64f6.9d67.a006
State: SIGNAL_DEGRADED
Elapsed time in this state: 00:00:43
Nominal Bandwidth: 600 Mbps
Current Bandwidth: 500 Mbps
Lowest Bandwidth: 500 Mbps
Last VSM Received: Thu Apr 30 11:03:45.493
```

```
VSM Receive Count: 1
VSM Drop Count: 0
VSM Period: 10 seconds
Hold Timer: Not running
Wait-to-Restore Timer: 1 seconds remaining
Periodic Timer: Not running
Transitions into degraded state: 1
```

The following is sample output from the **show ethernet event microwave status** command where Port-channel20 has been specified. Use the command to confirm that the configuration is performing as intended.

```
Device# show ethernet event microwave status interface Port-channel20/2

Microwave Bandwidth Status for Port-channel20
State: SIGNAL_DEGRADED
Hold Time: 0 seconds
Restore Time: 10 seconds
Loss Threshold: 3
Total VSM Receive Count: 2
Total VSM Drop Count: 0

Sender Address 64f6.9d67.a053
State: SIGNAL_DEGRADED
Elapsed time in this state: 00:00:26
Nominal Bandwidth: 700 Mbps
Current Bandwidth: 100 Mbps
Lowest Bandwidth: 100 Mbps
Last VSM Received: Fri Apr 24 13:09:13.245
VSM Receive Count: 2
VSM Drop Count: 0
VSM Period: 10 seconds
Hold Timer: Not running
Wait-to-Restore Timer: Not running
Periodic Timer: 29 seconds remaining
Transitions into degraded state: 1
```

The following is sample output from the **show ethernet event microwave status** command displaying the for Link ID TLVs:

```
Device# show ethernet event microwave status GigabitEthernet 0/0/2
Microwave Bandwidth Status for Ethernet0/0
  State:                    SIGNAL_DEGRADED
  Hold Time:                0 seconds
  Restore Time:             10 seconds
  Loss threshold:           3
  Total VSM Receive Count: 6
  Total VSM Drop Count:     0

  Link ID 4 (Sender Address aaa.bbbb.cccc)
    State:                    SIGNAL_OK
    Elapsed time in this state:    01:12:10
    Nominal Bandwidth:        10000 Mbps
    Current Bandwidth:        10000 Mbps
    Lowest Bandwidth:         N/A, not in degraded state
    Last VSM Received:        Fri Jan 24 10:24:43.349
    VSM Receive Count:        3
    VSM Drop Count:           0
    Hold Timer:               Not running
    Wait-to-Restore Timer:    Not running
```

```
    Periodic Timer:                Not running
    Transitions into degraded state: 2
```

The following is sample output from the **show ethernet event microwave statistics** command where GigabitEthernet interface 0/0/2 has been specified:

```
Device#show ethernet event microwave statistics GigabitEthernet 0/0/2

Microwave Bandwidth Status for GigabitEthernet0/0/2
State: SIGNAL_OK
Hold Time: 0 seconds
Restore Time: 10 seconds
Loss Threshold: 3
Total VSM Receive Count: 0
Total VSM Drop Count: 0

Sender Address 64f6.9d67.a00a
State: SIGNAL_OK
Elapsed time in this state: 00:02:58
Nominal Bandwidth: 900 Mbps
Current Bandwidth: 900 Mbps
Lowest Bandwidth: N/A, not in degraded state
Last VSM Received: Fri Apr 24 13:57:42.600
VSM Receive Count: 0
VSM Drop Count: 0
VSM Period: 60 seconds
Hold Timer: Not running
Wait-to-Restore Timer: Not running
Periodic Timer: Not running
Transitions into degraded state: 0
```

Example: Signal Degraded Event Syslog Messages

This example shows the sample output of signal degraded event syslog messages

```
Apr 30 16:33:45.497 IST: %ETHERNET_EVENT-4-MW_BW_CHANGE:
Available microwave bandwidth for link with source MAC 64F6.9D67.A006, link ID 0 on
GigabitEthernet0/0/7 has changed due to VSM,
current is 500Mbps, nominal is 600Mbps.
Apr 30 16:33:45.502 IST: %HA_EM-6-LOG: DEGRADED: eem started
```

Example: Configuring the TRUNK EFP with ACM Microwave

The following example shows the configuration of MEP on a trunk EFP.

```
interface GigabitEthernet0/3/3
no ip address
negotiation auto
ethernet cfm mep domain md1 mpid 1 service ma1
service instance trunk 1 ethernet
encapsulation dot1q 1-109
rewrite ingress tag pop 1 symmetric
l2protocol peer lacp
bridge-domain from-encapsulation
!
End
```

The MEP is configured outside EFP. The corresponding domain/service configuration would look like:

```
ethernet cfm ieee
ethernet cfm global
ethernet cfm domain md1 level 1
service ma1 evc evc1 vlan 100 direction down
continuity-check
```