



Interface and Hardware Component Configuration Guide for Cisco NCS 5000 Series Routers, IOS XR Release 6.1.x

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Preface

The *Interface and Hardware Component Configuration Guide for Cisco NCS 5000 Series Routers* provides information and procedures related to router interface and hardware configuration.

The preface contains the following sections:

- [Changes to This Document, on page ix](#)
- [Obtaining Documentation and Submitting a Service Request, on page ix](#)

Changes to This Document

This table lists the technical changes made to this document since it was first released.

Table 1: Changes to This Document

Date	Summary
May 2017	Added ERSPAN and LACP Fallback features.
February 2017	Added IP-in-IP De-capsulation feature for Release 6.1.3
November 2016	Initial release of this document.

Obtaining Documentation and Submitting a Service Request

For information on obtaining documentation, submitting a service request, and gathering additional information, see the monthly *What's New in Cisco Product Documentation*, which also lists all new and revised Cisco technical documentation, at: <http://www.cisco.com/c/en/us/td/docs/general/whatsnew/whatsnew.html>

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CHAPTER

1

New and Changed Feature Information

This table summarizes the new and changed feature information for the *Interface and Hardware Component Configuration Guide for Cisco NCS 5000 Series Routers*, and tells you where they are documented.

- [New and Changed Information](#), on page 1

New and Changed Information

Table 2: New and Changed Features

Feature	Description	Changed in Release	Where Documented
Integrated Routing and Bridging	This feature was introduced.	Release 6.1.3	<i>Configuring Integrated and Bridging</i> chapter
ERSPAN	This feature was introduced.	Release 6.1.31	<i>Configuring Traffic Monitoring</i> chapter
LACP Fallback	This feature was introduced.	Release 6.1.31	<i>Configuring Link Bundling</i> chapter



CHAPTER 2

Preconfiguring Physical Interfaces

This module describes the preconfiguration of physical interfaces.

Preconfiguration is supported for these types of interfaces and controllers:

- Gigabit Ethernet
- 10-Gigabit Ethernet
- 100-Gigabit Ethernet
- Management Ethernet

Preconfiguration allows you to configure line cards before they are inserted into the router. When the cards are inserted, they are instantly configured. The preconfiguration information is created in a different system database tree, rather than with the regularly configured interfaces. That database tree is known as the *preconfiguration directory* on the route processor.

There may be some preconfiguration data that cannot be verified unless the line card is present, because the verifiers themselves run only on the line card. Such preconfiguration data is verified when the line card is inserted and the verifiers are initiated. A configuration is rejected if errors are found when the configuration is copied from the preconfiguration area to the active area.



Note One Gigabit Ethernet interface is not supported. Only physical interfaces can be preconfigured.



Note From Cisco IOS XR Release 6.3.2, a six-seconds delay is introduced in error propagation from the driver to DPA for the MACSec line card and Oldcastle platforms. As a result, the BER algorithm on these platforms knows the error with a delay of 6 seconds.

- [Physical Interface Preconfiguration Overview](#), on page 4
- [Prerequisites for Preconfiguring Physical Interfaces](#), on page 4
- [Benefits of Interface Preconfiguration](#), on page 4
- [How to Preconfigure Physical Interfaces](#), on page 5
- [Information About Preconfiguring Physical Interfaces](#), on page 6

Physical Interface Preconfiguration Overview

Preconfiguration is the process of configuring interfaces before they are present in the system. Preconfigured interfaces are not verified or applied until the actual interface with the matching location (rack/slot/module) is inserted into the router. When the anticipated line card is inserted and the interfaces are created, the precreated configuration information is verified and, if successful, immediately applied to the running configuration of the router.



Note When you plug the anticipated line card in, make sure to verify any preconfiguration with the appropriate **show** commands.

Use the **show run** command to see interfaces that are in the preconfigured state.



Note We recommend filling out preconfiguration information in your site planning guide, so that you can compare that anticipated configuration with the actual preconfigured interfaces when that card is installed and the interfaces are up.



Tip Use the **commit best-effort** command to save the preconfiguration to the running configuration file. The **commit best-effort** command merges the target configuration with the running configuration and commits only valid configuration (best effort). Some configuration might fail due to semantic errors, but the valid configuration still comes up.

Prerequisites for Preconfiguring Physical Interfaces

Before preconfiguring physical interfaces, ensure that this condition is met:

- Preconfiguration drivers and files are installed. Although it may be possible to preconfigure physical interfaces without a preconfiguration driver installed, the preconfiguration files are required to set the interface definition file on the router that supplies the strings for valid interface names.

Benefits of Interface Preconfiguration

Preconfigurations reduce downtime when you add new cards to the system. With preconfiguration, the new line card can be instantly configured and actively running during line card bootup.

Another advantage of performing a preconfiguration is that during a card replacement, when the line card is removed, you can still see the previous configuration and make modifications.

How to Preconfigure Physical Interfaces

This task describes only the most basic preconfiguration of an interface.

SUMMARY STEPS

1. **configure**
2. **interface preconfigure** *type interface-path-id*
3. Use one of the following commands:
 - **ipv4 address** *ip-address subnet-mask*
 - **ipv4 address** *ip-address /prefix*
4. Configure additional interface parameters, as described in this manual in the configuration chapter that applies to the type of interface that you are configuring.
5. **end** or **commit** best-effort
6. **show running-config**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router#configure
```

Enters global configuration mode.

Step 2 **interface preconfigure** *type interface-path-id*

Example:

```
RP/0/RP0/CPU0:router(config)# interface preconfigure HundredGigE 0/3/0/2
```

Enters interface preconfiguration mode for an interface, where *type* specifies the supported interface type that you want to configure and *interface-path-id* specifies the location where the interface will be located in *rack/slot/module/port* notation.

Step 3 Use one of the following commands:

- **ipv4 address** *ip-address subnet-mask*
- **ipv4 address** *ip-address /prefix*

Example:

```
RP/0/RP0/CPU0:router(config-if-pre)# ipv4 address 192.168.1.2/31
```

Assigns an IP address and mask to the interface.

Step 4 Configure additional interface parameters, as described in this manual in the configuration chapter that applies to the type of interface that you are configuring.

Step 5 **end** or **commit** best-effort

Example:

```
RP/0/RP0/CPU0:router(config-if-pre)# end
```

or

```
RP/0/RP0/CPU0:router(config-if-pre)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes: `Uncommitted changes found, commit them before exiting (yes/no/cancel)?`
- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit best-effort** command to save the configuration changes to the running configuration file and remain within the configuration session. The **commit best-effort** command merges the target configuration with the running configuration and commits only valid changes (best effort). Some configuration changes might fail due to semantic errors.

Step 6 show running-config**Example:**

```
RP/0/RP0/CPU0:router# show running-config
```

(Optional) Displays the configuration information currently running on the router.

Example

This example shows how to preconfigure a basic Ethernet interface:

```
RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)#
RP/0/RP0/CPU0:router(config-if)# ipv4 address 192.168.1.2/31
RP/0/RP0/CPU0:router(config-if-pre)# commit
```

Information About Preconfiguring Physical Interfaces

To preconfigure interfaces, you must understand these concepts:

Use of the Interface Preconfigure Command

Interfaces that are not yet present in the system can be preconfigured with the **interface preconfigure** command in global configuration mode.

The **interface preconfigure** command places the router in interface configuration mode. Users should be able to add any possible interface commands. The verifiers registered for the preconfigured interfaces verify the configuration. The preconfiguration is complete when the user enters the **end** command, or any matching exit or global configuration mode command.



Note It is possible that some configurations cannot be verified until the line card is inserted.

Do not enter the **no shutdown** command for new preconfigured interfaces, because the no form of this command removes the existing configuration, and there is no existing configuration.

Users are expected to provide names during preconfiguration that will match the name of the interface that will be created. If the interface names do not match, the preconfiguration cannot be applied when the interface is created. The interface names must begin with the interface type that is supported by the router and for which drivers have been installed. However, the slot, port, subinterface number, and channel interface number information cannot be validated.



Note Specifying an interface name that already exists and is configured (or an abbreviated name like Hu0/3/0/0) is not permitted.



CHAPTER 3

Advanced Configuration and Modification of the Management Ethernet Interface

This module describes the configuration of Management Ethernet interfaces.

Before you can use Telnet to access the router through the LAN IP address, you must set up a Management Ethernet interface and enable Telnet servers.



Note Although the Management Ethernet interfaces on the system are present by default, the user must configure these interfaces to use them for accessing the router, using protocols and applications such as Simple Network Management Protocol (SNMP), HTTP, extensible markup language (XML), TFTP, Telnet, and command-line interface (CLI).

- [Prerequisites for Configuring Management Ethernet Interfaces, on page 9](#)
- [How to Perform Advanced Management Ethernet Interface Configuration, on page 10](#)
- [Information About Configuring Management Ethernet Interfaces, on page 16](#)

Prerequisites for Configuring Management Ethernet Interfaces

Before performing the Management Ethernet interface configuration procedures that are described in this chapter, be sure that the following tasks and conditions are met:

- You have performed the initial configuration of the Management Ethernet interface.
- You know how to apply the generalized interface name specification *rack/slot/module/port*.



Note For transparent switchover, both active and standby Management Ethernet interfaces are expected to be physically connected to the same LAN or switch.

How to Perform Advanced Management Ethernet Interface Configuration

This section contains the following procedures:

Configuring a Management Ethernet Interface

Perform this task to configure a Management Ethernet interface. This procedure provides the minimal configuration required for the Management Ethernet interface.

SUMMARY STEPS

1. **configure**
2. **interface MgmtEth** *interface-path-id*
3. **ipv4 address** *ip-address mask*
4. **mtu** *bytes*
5. **no shutdown**
6. **end** or **commit**
7. **show interfaces MgmtEth** *interface-path-id*

DETAILED STEPS

Step 1 **configure****Example:**

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **interface MgmtEth** *interface-path-id***Example:**

```
RP/0/RP0/CPU0:router(config)# interface MgmtEth 0/RP0/CPU0/0
```

Enters interface configuration mode and specifies the Ethernet interface name and notation *rack/slot/module/port*.

The example indicates port 0 on the RP card that is installed in slot 0.

Step 3 **ipv4 address** *ip-address mask***Example:**

```
RP/0/RP0/CPU0:router(config-if)# ipv4 address 1.76.18.150/16 (or)  
ipv4 address 1.76.18.150 255.255.0.0
```

Assigns an IP address and subnet mask to the interface.

- Replace *ip-address* with the primary IPv4 address for the interface.

- Replace *mask* with the mask for the associated IP subnet. The network mask can be specified in either of two ways:
- The network mask can be a four-part dotted decimal address. For example, 255.255.0.0 indicates that each bit equal to 1 means that the corresponding address bit belongs to the network address.
- The network mask can be indicated as a slash (/) and number. For example, /16 indicates that the first 16 bits of the mask are ones, and the corresponding bits of the address are network address.

Step 4 `mtu bytes`**Example:**

```
RP/0/RP0/CPU0:router(config-if)# mtu 1488
```

(Optional) Sets the maximum transmission unit (MTU) byte value for the interface. The default is 1514.

- The default is 1514 bytes.
- The range for the Management Ethernet interface Interface **mtu** values is 64 to 1514 bytes.

Step 5 `no shutdown`**Example:**

```
RP/0/RP0/CPU0:router(config-if)# no shutdown
```

Removes the shutdown configuration, which removes the forced administrative down on the interface, enabling it to move to an up or down state.

Step 6 `end` or `commit`**Example:**

```
RP/0/RP0/CPU0:router(config-if)# end
```

or

```
RP/0/RP0/CPU0:router(config-if)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?  
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Step 7 show interfaces MgmtEth *interface-path-id***Example:**

```
RP/0/RP0/CPU0:router# show interfaces MgmtEth 0/RP0/CPU0/0
```

(Optional) Displays statistics for interfaces on the router.

Example

This example displays advanced configuration and verification of the Management Ethernet interface on the RP:

```
RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)# interface MgmtEth 0/RP0/CPU0/0
RP/0/RP0/CPU0:router(config)# ipv4 address 1.76.18.150/16
RP/0/RP0/CPU0:router(config-if)# no shutdown
RP/0/RP0/CPU0:router(config-if)# commit
RP/0/RP0/CPU0:router:Mar 26 01:09:28.685 :ifmgr[190]:%LINK-3-UPDOWN :Interface
MgmtEth0/RP0/CPU0/0, changed state to Up
RP/0/RP0/CPU0:router(config-if)# end

RP/0/RP0/CPU0:router# show interfaces MgmtEth 0/RP0/CPU0/0

MgmtEth0/RP0/CPU0/0 is up, line protocol is up
  Interface state transitions: 3
  Hardware is Management Ethernet, address is 1005.cad8.4354 (bia 1005.cad8.4354)
  Internet address is 1.76.18.150/16
  MTU 1488 bytes, BW 1000000 Kbit (Max: 1000000 Kbit)
    reliability 255/255, txload 0/255, rxload 0/255
  Encapsulation ARPA,
  Full-duplex, 1000Mb/s, 1000BASE-T, link type is autonegotiation
  loopback not set,
  Last link flapped 00:00:59
  ARP type ARPA, ARP timeout 04:00:00
  Last input 00:00:00, output 00:00:02
  Last clearing of "show interface" counters never
  5 minute input rate 4000 bits/sec, 3 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    21826 packets input, 4987886 bytes, 0 total input drops
    0 drops for unrecognized upper-level protocol
    Received 12450 broadcast packets, 8800 multicast packets
      0 runts, 0 giants, 0 throttles, 0 parity
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
    1192 packets output, 217483 bytes, 0 total output drops
  Output 0 broadcast packets, 0 multicast packets
  0 output errors, 0 underruns, 0 applique, 0 resets
  0 output buffer failures, 0 output buffers swapped out
  3 carrier transitions

RP/0/RP0/CPU0:router# show running-config interface MgmtEth 0/RP0/CPU0/0

interface MgmtEth0/RP0/CPU0/0
  mtu 1488
  ipv4 address 1.76.18.150/16
  ipv6 address 2002::14c:125a/64
```

```
ipv6 enable
!
```

The following example displays VRF configuration and verification of the Management Ethernet interface on the RP with source address:

```
RP/0/RP0/CPU0:router# show run interface MgmtEth 0/RP0/CPU0/0
interface MgmtEth0/RP0/CPU0/0
 vrf httpupload
 ipv4 address 10.8.67.20 255.255.0.0
 ipv6 address 2001:10:8:67::20/48
!
```

```
RP/0/RP0/CPU0:router# show run http
Wed Jan 30 14:58:53.458 UTC
http client vrf httpupload
http client source-interface ipv4 MgmtEth0/RP0/CPU0/0
```

```
RP/0/RP0/CPU0:router# show run vrf
Wed Jan 30 14:59:00.014 UTC
vrf httpupload
!
```

IPv6 Stateless Address Auto Configuration on Management Interface

Perform this task to enable IPv6 stateless auto configuration on Management interface.

SUMMARY STEPS

1. **configure**
2. **interface MgmtEth** *interface-path-id*
3. **ipv6 address autoconfig**
4. **show ipv6 interfaces** *interface-path-id*

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
Enters global configuration mode.
```

Step 2 **interface MgmtEth** *interface-path-id*

Example:

```
RP/0/RP0/CPU0:router(config)# interface MgmtEth 0/RP0/CPU0/0
Enters interface configuration mode and specifies the Ethernet interface name and notation rack/slot/module/port.
The example indicates port 0 on the RP card that is installed in slot 0.
```

Step 3 **ipv6 address autoconfig**

Example:

```
RP/0/RP0/CPU0:router(config-if)# ipv6 address autoconfig
```

Enable IPv6 stateless address auto configuration on the management port.

Step 4 **show ipv6 interfaces** *interface-path-id***Example:**

```
RP/0/RP0/CPU0:router# show ipv6 interfaces gigabitEthernet 0/2/0/0
```

(Optional) Displays statistics for interfaces on the router.

Example

This example displays :

```
RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)# interface MgmtEth 0/RP0/CPU0/0
RP/0/RP0/CPU0:router(config)# ipv6 address autoconfig
RP/0/RP0/CPU0:router# show ipv6 interfaces gigabitEthernet 0/2/0/0

Fri Nov 4 16:48:14.372 IST
GigabitEthernet0/2/0/0 is Up, ipv6 protocol is Up, Vrfid is default (0x60000000)
  IPv6 is enabled, link-local address is fe80::d1:1eff:fe2b:baf
  Global unicast address(es):
    5::d1:1eff:fe2b:baf [AUTO CONFIGURED], subnet is 5::/64 <<<<<< auto configured address

  Joined group address(es): ff02::1:ff2b:baf ff02::2 ff02::1
  MTU is 1514 (1500 is available to IPv6)
  ICMP redirects are disabled
  ICMP unreachable are enabled
  ND DAD is enabled, number of DAD attempts 1
  ND reachable time is 0 milliseconds
  ND cache entry limit is 1000000000
  ND advertised retransmit interval is 0 milliseconds
  Hosts use stateless autoconfig for addresses.
  Outgoing access list is not set
  Inbound common access list is not set, access list is not set
  Table Id is 0xe0800000
  Complete protocol adjacency: 0
  Complete glean adjacency: 0
  Incomplete protocol adjacency: 0
  Incomplete glean adjacency: 0
  Dropped protocol request: 0
  Dropped glean request: 0
```

Modifying the MAC Address for a Management Ethernet Interface

Perform this task to configure the MAC layer address of the Management Ethernet interfaces for the RPs.

SUMMARY STEPS**1. configure**

2. **interface MgmtEth** *interface-path-id*
3. **mac-address** *address*
4. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **interface MgmtEth** *interface-path-id*

Example:

```
RP/0/RP0/CPU0:router(config)# interface MgmtEth 0/RP0/CPU0/0
```

Enters interface configuration mode and specifies the Management Ethernet interface name and instance.

Step 3 **mac-address** *address*

Example:

```
RP/0/RP0/CPU0:router(config-if)# mac-address 0001.2468.ABCD
```

Configures the MAC layer address of the Management Ethernet interface.

Note • To return the device to its default MAC address, use the **no mac-address** address command.

Step 4 **end** or **commit**

Example:

```
RP/0/RP0/CPU0:router(config-if)# end
```

or

```
RP/0/RP0/CPU0:router(config-if)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?  
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.

- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
 - Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.
-

Verifying Management Ethernet Interface Configuration

Perform this task to verify configuration modifications on the Management Ethernet interfaces.

SUMMARY STEPS

1. **show interfaces MgmtEth *interface-path-id***
2. **show running-config interface MgmtEth *interface-path-id***

DETAILED STEPS

Step 1 **show interfaces MgmtEth *interface-path-id***

Example:

```
RP/0/RP0/CPU0:router# show interfaces MgmtEth 0/RP0/CPU0/0
```

Displays the Management Ethernet interface configuration.

Step 2 **show running-config interface MgmtEth *interface-path-id***

Example:

```
RP/0/RP0/CPU0:router# show running-config interface MgmtEth 0/RP0/CPU0/0
```

Displays the running configuration.

Information About Configuring Management Ethernet Interfaces

To configure Management Ethernet interfaces, you must understand the following concept:



CHAPTER 4

Configuring Ethernet Interfaces

This module describes the configuration of Ethernet interfaces.

The following distributed ethernet architecture delivers network scalability and performance, while enabling service providers to offer high-density, high-bandwidth networking solutions.

- 100-Megabit
- 1-Gigabit
- 100-Gigabit

These solutions are designed to interconnect the router with other systems in POPs, including core and edge routers and Layer 2 and Layer 3 switches.

Restrictions

Router does not support configuration of the static mac address.

- [Configuring Gigabit Ethernet Interfaces, on page 17](#)
- [Information About Configuring Ethernet, on page 21](#)

Configuring Gigabit Ethernet Interfaces

Use this procedure to create a basic Ethernet interface configuration.

SUMMARY STEPS

1. **show version**
2. **show interfaces [GigE TenGigE HundredGigE] *interface-path-id***
3. **configure**
4. **interface [GigE TenGigE HundredGigE] *interface-path-id***
5. **ipv4 address *ip-address mask***
6. **flow-control {bidirectional| egress | ingress}**
7. **mtu *bytes***
8. **negotiation auto**
9. **no shutdown**
10. **end or commit**

11. show interfaces [GigE TenGigE HundredGigE] interface-path-id

DETAILED STEPS

Step 1 show version

Example:

```
RP/0/RP0/CPU0:router# show version
```

(Optional) Displays the current software version, and can also be used to confirm that the router recognizes the line card.

Step 2 show interfaces [GigE TenGigE HundredGigE] interface-path-id

Example:

```
RP/0/RP0/CPU0:router# show interface HundredGigE 0/1/0/1
```

(Optional) Displays the configured interface and checks the status of each interface port.

Step 3 configure

Example:

```
RP/0/RP0/CPU0:router# configure terminal
```

Enters global configuration mode.

Step 4 interface [GigE TenGigE HundredGigE] interface-path-id

Example:

```
RP/0/RP0/CPU0:router(config)# interface HundredGigE 0/1/0/1
```

Enters interface configuration mode and specifies the Ethernet interface name and notation *rack/slot/module/port*. Possible interface types for this procedure are:

- GigE
- 10GigE
- 100GigE

Note • The example indicates a 100-Gigabit Ethernet interface in the line card in slot 1.

Step 5 ipv4 address ip-address mask

Example:

```
RP/0/RP0/CPU0:router(config-if)# ipv4 address 172.18.189.38 255.255.255.224
```

Assigns an IP address and subnet mask to the interface.

- Replace *ip-address* with the primary IPv4 address for the interface.

- Replace *mask* with the mask for the associated IP subnet. The network mask can be specified in either of two ways:
- The network mask can be a four-part dotted decimal address. For example, 255.0.0.0 indicates that each bit equal to 1 means that the corresponding address bit belongs to the network address.
- The network mask can be indicated as a slash (/) and number. For example, /8 indicates that the first 8 bits of the mask are ones, and the corresponding bits of the address are network address.

Step 6 **flow-control {bidirectional| egress | ingress}****Example:**

```
RP/0/RP0/CPU0:router(config-if)# flow control ingress
```

(Optional) Enables the sending and processing of flow control pause frames.

- **egress**—Enables the sending of flow control pause frames in egress.
- **ingress**—Enables the processing of received pause frames on ingress.
- **bidirectional**—Enables the sending of flow control pause frames in egress and the processing of received pause frames on ingress.

Step 7 **mtu bytes****Example:**

```
RP/0/RP0/CPU0:router(config-if)# mtu 1448
```

(Optional) Sets the MTU value for the interface.

- The default is 1514 bytes for normal frames and 1518 bytes for 802.1Q tagged frames.
- The range for 100-Gigabit Ethernet mtu values is 64 bytes to 65535 bytes.

Step 8 **negotiation auto****Example:**

```
RP/0/RP0/CPU0:router(config-if)# negotiation auto
```

(Optional) Enables autonegotiation on a Gigabit Ethernet interface.

- Autonegotiation must be explicitly enabled on both ends of the connection, or speed and duplex settings must be configured manually on both ends of the connection.
- If autonegotiation is enabled, any speed or duplex settings that you configure manually take precedence.

Note • The **negotiation auto** command is available on Gigabit Ethernet interfaces only.

Step 9 **no shutdown****Example:**

```
RP/0/RP0/CPU0:router(config-if)# no shutdown
```

Removes the shutdown configuration, which forces an interface administratively down.

Step 10 **end** or **commit****Example:**

```
RP/0/RP0/CPU0:router(config-if)# end
```

or

```
RP/0/RP0/CPU0:router(config-if)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Step 11 **show interfaces [GigE TenGigE HundredGigE] interface-path-id****Example:**

```
RP/0/RP0/CPU0:router# show interfaces HundredGigE 0/1/0/1
```

(Optional) Displays statistics for interfaces on the router.

Example

This example shows how to configure an interface for a 100-Gigabit Ethernet line card:

```
RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)# interface HundredGigE 0/1/0/1
RP/0/RP0/CPU0:router(config-if)# ipv4 address 172.18.189.38 255.255.255.224
RP/0/RP0/CPU0:router(config-if)# flow-control ingress
RP/0/RP0/CPU0:router(config-if)# mtu 1448

RP/0/RP0/CPU0:router(config-if)# no shutdown
RP/0/RP0/CPU0:router(config-if)# end
Uncommitted changes found, commit them? [yes]: yes

RP/0/RP0/CPU0:router# show interfaces HundredGigE 0/5/0/24
```

```

HundredGigE0/5/0/24 is up, line protocol is up
  Interface state transitions: 1
  Hardware is HundredGigE, address is 6219.8864.e330 (bia 6219.8864.e330)
  Internet address is 3.24.1.1/24
  MTU 9216 bytes, BW 100000000 Kbit (Max: 100000000 Kbit)
    reliability 255/255, txload 3/255, rxload 3/255
  Encapsulation ARPA,
  Full-duplex, 100000Mb/s, link type is force-up
  output flow control is off, input flow control is off
  Carrier delay (up) is 10 msec
  loopback not set,
  Last link flapped 10:05:07
  ARP type ARPA, ARP timeout 04:00:00
  Last input 00:08:56, output 00:00:00
  Last clearing of "show interface" counters never
  5 minute input rate 1258567000 bits/sec, 1484160 packets/sec
  5 minute output rate 1258584000 bits/sec, 1484160 packets/sec
    228290765840 packets input, 27293508436038 bytes, 0 total input drops
    0 drops for unrecognized upper-level protocol
  Received 15 broadcast packets, 45 multicast packets
    0 runts, 0 giants, 0 throttles, 0 parity
    0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
  212467849449 packets output, 25733664696650 bytes, 0 total output drops
  Output 23 broadcast packets, 15732 multicast packets
  39 output errors, 0 underruns, 0 applique, 0 resets
  0 output buffer failures, 0 output buffers swapped out
  0 carrier transitions

```

```
RP/0/RP0/CPU0:router# show running-config interface HundredGigE 0/5/0/24
```

```

interface HundredGigE 0/5/0/24
  mtu 9216
  service-policy input linerate
  service-policy output elinerate
  ipv4 address 3.24.1.1 255.255.255.0
  ipv6 address 3:24:1::1/64
  flow ipv4 monitor perfv4 sampler fsm ingress
!
```

Information About Configuring Ethernet

This section provides the following information sections:

Default Configuration Values for 100-Gigabit Ethernet

This table describes the default interface configuration parameters that are present when an interface is enabled on a 10-Gigabit Ethernet or 100-Gigabit Ethernet line card.



Note You must use the **shutdown** command to bring an interface administratively down. The interface default is **no shutdown**. When a line card is first inserted into the router, if there is no established preconfiguration for it, the configuration manager adds a shutdown item to its configuration. This shutdown can be removed only by entering the **no shutdown** command.

Table 3: 100-Gigabit Ethernet Line Card Default Configuration Values

Parameter	Configuration File Entry	Default Value
Flow control	flow-control	egress on ingress off
MTU	mtu	<ul style="list-style-type: none"> • 1514 bytes for normal frames • 1518 bytes for 802.1Q tagged frames. • 1522 bytes for Q-in-Q frames.
MAC address	mac address	Hardware burned-in address (BIA)

Ethernet MTU

The Ethernet maximum transmission unit (MTU) is the size of the largest frame, minus the 4-byte frame check sequence (FCS), that can be transmitted on the Ethernet network. Every physical network along the destination of a packet can have a different MTU.

Cisco IOS XR software supports two types of frame forwarding processes:

- Fragmentation for IPV4 packets—In this process, IPv4 packets are fragmented as necessary to fit within the MTU of the next-hop physical network.



Note IPv6 does not support fragmentation.

- MTU discovery process determines largest packet size—This process is available for all IPV6 devices, and for originating IPv4 devices. In this process, the originating IP device determines the size of the largest IPv6 or IPV4 packet that can be sent without being fragmented. The largest packet is equal to the smallest MTU of any network between the IP source and the IP destination devices. If a packet is larger than the smallest MTU of all the networks in its path, that packet will be fragmented as necessary. This process ensures that the originating device does not send an IP packet that is too large.

Jumbo frame support is automatically enable for frames that exceed the standard frame size. The default value is 1514 for standard frames and 1518 for 802.1Q tagged frames. These numbers exclude the 4-byte frame check sequence (FCS).

802.1Q VLAN

A VLAN is a group of devices on one or more LANs that are configured so that they can communicate as if they were attached to the same wire, when in fact they are located on a number of different LAN segments. Because VLANs are based on logical instead of physical connections, it is very flexible for user and host management, bandwidth allocation, and resource optimization.

The IEEE's 802.1Q protocol standard addresses the problem of breaking large networks into smaller parts so broadcast and multicast traffic does not consume more bandwidth than necessary. The standard also helps provide a higher level of security between segments of internal networks.

The 802.1Q specification establishes a standard method for inserting VLAN membership information into Ethernet frames.

VRRP

The Virtual Router Redundancy Protocol (VRRP) eliminates the single point of failure inherent in the static default routed environment. VRRP specifies an election protocol that dynamically assigns responsibility for a virtual router to one of the VPN concentrators on a LAN. The VRRP VPN concentrator controlling the IP addresses associated with a virtual router is called the master, and forwards packets sent to those IP addresses. When the master becomes unavailable, a backup VPN concentrator takes the place of the master.

HSRP

Hot Standby Routing Protocol (HSRP) is a proprietary protocol from Cisco. HSRP is a routing protocol that provides backup to a router in the event of failure. Several routers are connected to the same segment of an Ethernet, FDDI, or token-ring network and work together to present the appearance of a single virtual router on the LAN. The routers share the same IP and MAC addresses and therefore, in the event of failure of one router, the hosts on the LAN are able to continue forwarding packets to a consistent IP and MAC address. The transfer of routing responsibilities from one device to another is transparent to the user.

HSRP is designed to support non disruptive switchover of IP traffic in certain circumstances and to allow hosts to appear to use a single router and to maintain connectivity even if the actual first hop router they are using fails. In other words, HSRP protects against the failure of the first hop router when the source host cannot learn the IP address of the first hop router dynamically. Multiple routers participate in HSRP and in concert create the illusion of a single virtual router. HSRP ensures that one and only one of the routers is forwarding packets on behalf of the virtual router. End hosts forward their packets to the virtual router.

The router forwarding packets is known as the *active router*. A standby router is selected to replace the active router should it fail. HSRP provides a mechanism for determining active and standby routers, using the IP addresses on the participating routers. If an active router fails a standby router can take over without a major interruption in the host's connectivity.

HSRP runs on top of User Datagram Protocol (UDP), and uses port number 1985. Routers use their actual IP address as the source address for protocol packets, not the virtual IP address, so that the HSRP routers can identify each other.

Subinterfaces

In Cisco IOS XR Software, interfaces are, by default, main interfaces. A main interface is also called a trunk interface, which is not to be confused with the usage of the word trunk in the context of VLAN trunking.

There are three types of trunk interfaces:

- Physical
- Bundle

The physical interfaces are automatically created when the router recognizes a card and its physical interfaces. However, bundle interfaces are not automatically created. They are created when they are configured by the user.

The following configuration samples are examples of trunk interfaces being created:

- interface HundredGigabitethernet 0/5/0/0
- interface bundle-ether 1

A subinterface is a logical interface that is created under a trunk interface.

To create a subinterface, the user must first identify a trunk interface under which to place it. In the case of bundle interfaces, if one does not already exist, a bundle interface must be created before any subinterfaces can be created under it.

The user then assigns a subinterface number to the subinterface to be created. The subinterface number must be a positive integer from zero to some high value. For a given trunk interface, each subinterface under it must have a unique value.

Subinterface numbers do not need to be contiguous or in numeric order. For example, the following subinterface numbers would be valid under one trunk interface:

```
1001, 0, 97, 96, 100000
```

Subinterfaces can never have the same subinterface number under one trunk.

In the following example, the card in slot 5 has trunk interface, HundredGigE 0/5/0/0. A subinterface, HundredGigE 0/5/0/0.0, is created under it.

```
RP/0/RP0/CPU0:router# conf
Mon Sep 21 11:12:11.722 EDT
RP/0/RP0/CPU0:router(config)# interface HundredGigE 0/5/0/0.0
RP/0/RP0/CPU0:router(config-subif)# encapsulation dot1q 100
RP/0/RP0/CPU0:router(config-subif)# commit

RP/0/RP0/CPU0:Sep 21 11:12:34.819 : config[65794]: %MGBL-CONFIG-6-DB_COMMIT : Configuration
committed by user 'root'. Use 'show configuration commit changes 1000000152' to view the
changes.

RP/0/RP0/CPU0:router(config-subif)# end

RP/0/RP0/CPU0:Sep 21 11:12:35.633 : config[65794]: %MGBL-SYS-5-CONFIG_I : Configured from
console by root
RP/0/RP0/CPU0:router#
```

The **show run** command displays the trunk interface first, then the subinterfaces in ascending numerical order.

```
RP/0/RP0/CPU0:router# show run | begin HundredGigE 0/5/0/0
Mon Sep 21 11:15:42.654 EDT
Building configuration...
interface GigabitEthernet0/5/0/0
 shutdown
 !
interface GigabitEthernet0/5/0/0.0
 encapsulation dot1q 100
 !
interface GigabitEthernet0/5/0/1
 shutdown
 !
```

When a subinterface is first created, the router recognizes it as an interface that, with few exceptions, is interchangeable with a trunk interface. After the new subinterface is configured further, the **show interface** command can display it along with its unique counters:

The following example shows the display output for the trunk interface, HundredGigE 0/5/0/0, followed by the display output for the subinterface HundredGigE 0/5/0/0.0.

```

RP/0/RP0/CPU0:router# show interface HundredGigE 0/5/0/0
Mon Sep 21 11:12:51.068 EDT
GigabitEthernet0/5/0/0 is administratively down, line protocol is administratively down.
  Interface state transitions: 0
  Hardware is GigabitEthernet, address is 0024.f71b.0ca8 (bia 0024.f71b.0ca8)
  Internet address is Unknown
  MTU 1514 bytes, BW 1000000 Kbit
    reliability 255/255, txload 0/255, rxload 0/255
  Encapsulation 802.1Q Virtual LAN,
  Full-duplex, 1000Mb/s, SXFD, link type is force-up
  output flow control is off, input flow control is off
  loopback not set,
  ARP type ARPA, ARP timeout 04:00:00
  Last input never, output never
  Last clearing of "show interface" counters never
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    0 packets input, 0 bytes, 0 total input drops
    0 drops for unrecognized upper-level protocol
  Received 0 broadcast packets, 0 multicast packets
    0 runts, 0 giants, 0 throttles, 0 parity
  0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
  0 packets output, 0 bytes, 0 total output drops
  Output 0 broadcast packets, 0 multicast packets
  0 output errors, 0 underruns, 0 applique, 0 resets
  0 output buffer failures, 0 output buffers swapped out
  0 carrier transitions

```

```

RP/0/RP0/CPU0:router# show interface HundredGigE 0/5/0/0.0
Mon Sep 21 11:12:55.657 EDT
GigabitEthernet0/5/0/0.0 is administratively down, line protocol is administratively down.
  Interface state transitions: 0
  Hardware is VLAN sub-interface(s), address is 0024.f71b.0ca8
  Internet address is Unknown
  MTU 1518 bytes, BW 1000000 Kbit
    reliability 255/255, txload 0/255, rxload 0/255
  Encapsulation 802.1Q Virtual LAN, VLAN Id 100, loopback not set,
  ARP type ARPA, ARP timeout 04:00:00
  Last input never, output never
  Last clearing of "show interface" counters never
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
    0 packets input, 0 bytes, 0 total input drops
    0 drops for unrecognized upper-level protocol
  Received 0 broadcast packets, 0 multicast packets
  0 packets output, 0 bytes, 0 total output drops
  Output 0 broadcast packets, 0 multicast packets

```

This example shows two interfaces being created at the same time: first, the bundle trunk interface, then a subinterface attached to the trunk:

```

RP/0/RP0/CPU0:router# conf
Mon Sep 21 10:57:31.736 EDT
RP/0/RP0/CPU0:router(config)# interface Bundle-Ether1
RP/0/RP0/CPU0:router(config-if)# no shut
RP/0/RP0/CPU0:router(config-if)# interface bundle-Ether1.0
RP/0/RP0/CPU0:router(config-subif)# encapsulation dot1q 100
RP/0/RP0/CPU0:router(config-subif)# commit
RP/0/RP0/CPU0:Sep 21 10:58:15.305 : config[65794]: %MGBL-CONFIG-6-DB_COMMIT : C
onfiguration committed by user 'root'. Use 'show configuration commit changes 10
00000149' to view the changes.
RP/0/RP0/CPU0:router# show run | begin Bundle-Ether1

```

```

Mon Sep 21 10:59:31.317 EDT
Building configuration..
interface Bundle-Ether1
!
interface Bundle-Ether1.0
 encapsulation dot1q 100
!

```

You delete a subinterface using the **no interface** command.

```

RP/0/RP0/CPU0:router#
RP/0/RP0/CPU0:router# show run | begin HundredGigE0/5/0/0
Mon Sep 21 11:42:27.100 EDT
Building configuration...
interface GigabitEthernet0/5/0/0
 negotiation auto
!
interface HundredGigE0/5/0/0.0
 encapsulation dot1q 100
!
interface HundredGigE0/5/0/1
 shutdown
!
RP/0/RP0/CPU0:router# conf
Mon Sep 21 11:42:32.374 EDT
RP/0/RP0/CPU0:router(config)# no interface GigabitEthernet0/5/0/0.0
RP/0/RP0/CPU0:router(config)# commit
RP/0/RP0/CPU0:Sep 21 11:42:47.237 : config[65794]: %MGBL-CONFIG-6-DB_COMMIT : Configuration
 committed by user 'root'. Use 'show configuration commit changes 1000000159' to view the
 changes.
RP/0/RP0/CPU0:router(config)# end
RP/0/RP0/CPU0:Sep 21 11:42:50.278 : config[65794]: %MGBL-SYS-5-CONFIG_I : Configured from
 console by root
RP/0/RP0/CPU0:router# show run | begin GigabitEthernet0/5/0/0
Mon Sep 21 11:42:57.262 EDT
Building configuration...
interface HundredGigE0/5/0/0
 negotiation auto
!
interface HundredGigE0/5/0/1
 shutdown
!

```



CHAPTER 5

Configuring Ethernet OAM

This module describes the configuration of Ethernet Operations, Administration, and Maintenance (OAM) .

Feature History for Configuring Ethernet OAM

Release	Modification
Release 6.1.1	Support for the following features was introduced: <ul style="list-style-type: none">• Ethernet CFM
Release 6.3.1	Support for the following feature was introduced: <ul style="list-style-type: none">• Unidirectional Link Detection Protocol

- [Configuring Ethernet OAM, on page 27](#)
- [Information About Configuring Ethernet OAM, on page 28](#)
- [How to Configure Ethernet OAM, on page 45](#)
- [Configuration Examples for Ethernet OAM, on page 65](#)

Configuring Ethernet OAM

This module describes the configuration of Ethernet Operations, Administration, and Maintenance (OAM) .

Feature History for Configuring Ethernet OAM

Release	Modification
Release 6.1.1	Support for the following features was introduced: <ul style="list-style-type: none">• Ethernet CFM
Release 6.3.1	Support for the following feature was introduced: <ul style="list-style-type: none">• Unidirectional Link Detection Protocol

Information About Configuring Ethernet OAM

To configure Ethernet OAM, you should understand the following concepts:

Ethernet Link OAM

Ethernet as a Metro Area Network (MAN) or a Wide Area Network (WAN) technology benefits greatly from the implementation of Operations, Administration and Maintenance (OAM) features. Ethernet link OAM features allow Service Providers to monitor the quality of the connections on a MAN or WAN. Service providers can monitor specific events, . Ethernet link OAM operates on a single, physical link and it can be configured to monitor either side or both sides of that link.

Ethernet link OAM can be configured in the following ways:

- A Link OAM profile can be configured, and this profile can be used to set the parameters for multiple interfaces.
- Link OAM can be configured directly on an interface.

When an interface is also using a link OAM profile, specific parameters that are set in the profile can be overridden by configuring a different value directly on the interface.

An Ethernet Link OAM profile simplifies the process of configuring EOAM features on multiple interfaces. An Ethernet OAM profile, and all of its features, can be referenced by other interfaces, allowing other interfaces to inherit the features of that Ethernet OAM profile.

Individual Ethernet link OAM features can be configured on individual interfaces without being part of a profile. In these cases, the individually configured features always override the features in the profile.

The preferred method of configuring custom EOAM settings is to create an EOAM profile in Ethernet configuration mode and then attach it to an individual interface or to multiple interfaces.

These standard Ethernet Link OAM features are supported on the router:

EFD

Ethernet Fault Detection (EFD) is a mechanism that allows Ethernet OAM protocols, such as CFM, to control the `line protocol` state of an interface.

Unlike many other interface types, Ethernet interfaces do not have a line protocol, whose state is independent from that of the interface. For Ethernet interfaces, this role is handled by the physical-layer Ethernet protocol itself, and therefore if the interface is physically up, then it is available and traffic can flow.

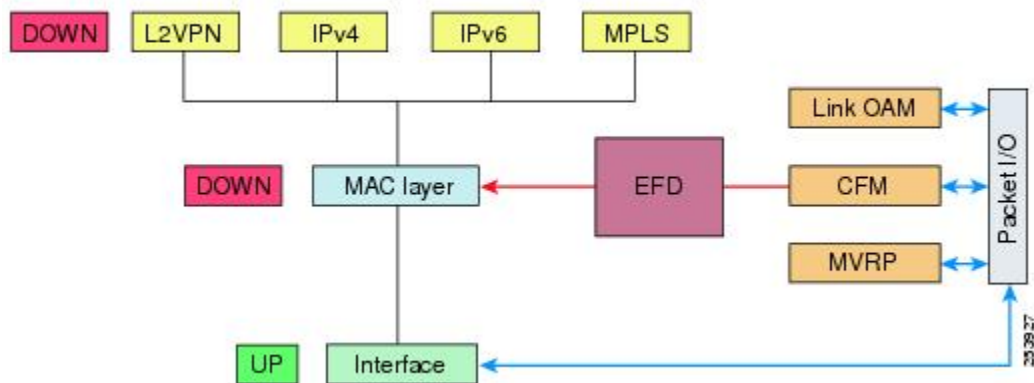
EFD changes this to allow CFM to act as the line protocol for Ethernet interfaces. This allows CFM to control the interface state so that if a CFM defect (such as AIS or loss of continuity) is detected with an expected peer MEP, the interface can be shut down. This not only stops traffic flow, but also triggers actions in any higher-level protocols to route around the problem. For example, in the case of Layer 2 interfaces, the MAC table would be cleared and MSTP would reconverge. For Layer 3 interfaces, the ARP cache would be cleared and potentially the IGP would reconverge.



Note EFD can only be used for down MEPs. When EFD is used to shut down the interface, the CFM frames continue to flow. This allows CFM to detect when the problem has been resolved, and thus bring the interface backup automatically.

This figure shows CFM detection of an error on one of its sessions EFD signaling an error to the corresponding MAC layer for the interface. This triggers the MAC to go to a down state, which further triggers all higher level protocols (Layer 2 pseudowires, IP protocols, and so on) to go down and also trigger a reconvergence where possible. As soon as CFM detects there is no longer any error, it can signal to EFD and all protocols will once again go active.

Figure 1: CFM Error Detection and EFD Trigger



Ethernet CFM

Ethernet Connectivity Fault Management (CFM) is a service-level OAM protocol that provides tools for monitoring and troubleshooting end-to-end Ethernet services per VLAN. This includes proactive connectivity monitoring, fault verification, and fault isolation. CFM uses standard Ethernet frames and can be run on any physical media that is capable of transporting Ethernet service frames. Unlike most other Ethernet protocols which are restricted to a single physical link, CFM frames can transmit across the entire end-to-end Ethernet network.

CFM is defined in two standards:

- IEEE 802.1ag—Defines the core features of the CFM protocol.
- ITU-T Y.1731—Redefines, but maintains compatibility with the features of IEEE 802.1ag, and defines some additional features.

Ethernet CFM supports these functions of ITU-T Y.1731:

- ETH-CC, ETH-RDI, ETH-LB, ETH-LT—These are equivalent to the corresponding features defined in IEEE 802.1ag.



Note The Linktrace responder procedures defined in IEEE 802.1ag are used rather than the procedures defined in Y.1731; however, these are interoperable.

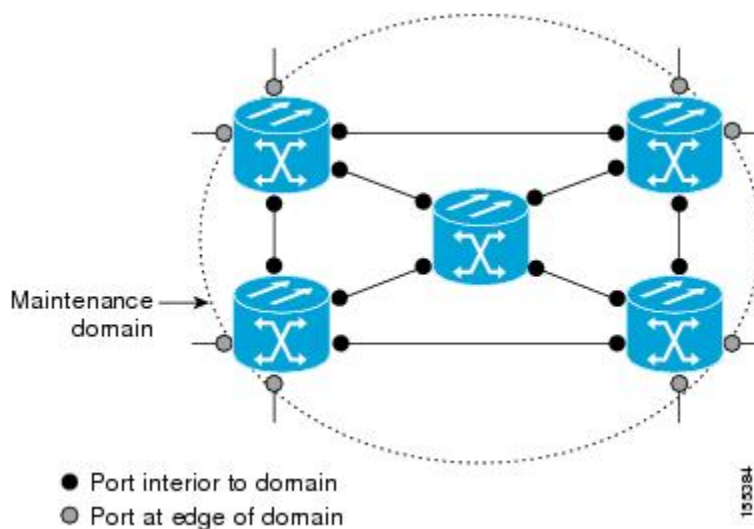
- ETH-AIS—The reception of ETH-LCK messages is also supported.

To understand how the CFM maintenance model works, you need to understand these concepts and features:

Maintenance Domains

A maintenance domain describes a management space for the purpose of managing and administering a network. A domain is owned and operated by a single entity and defined by the set of interfaces internal to it and at its boundary, as shown in this figure.

Figure 2: CFM Maintenance Domain



A maintenance domain is defined by the bridge ports that are provisioned within it. Domains are assigned maintenance levels, in the range of 0 to 7, by the administrator. The level of the domain is useful in defining the hierarchical relationships of multiple domains.

CFM maintenance domains allow different organizations to use CFM in the same network, but independently. For example, consider a service provider who offers a service to a customer, and to provide that service, they use two other operators in segments of the network. In this environment, CFM can be used in the following ways:

- The customer can use CFM between their CE devices, to verify and manage connectivity across the whole network.
- The service provider can use CFM between their PE devices, to verify and manage the services they are providing.
- Each operator can use CFM within their operator network, to verify and manage connectivity within their network.

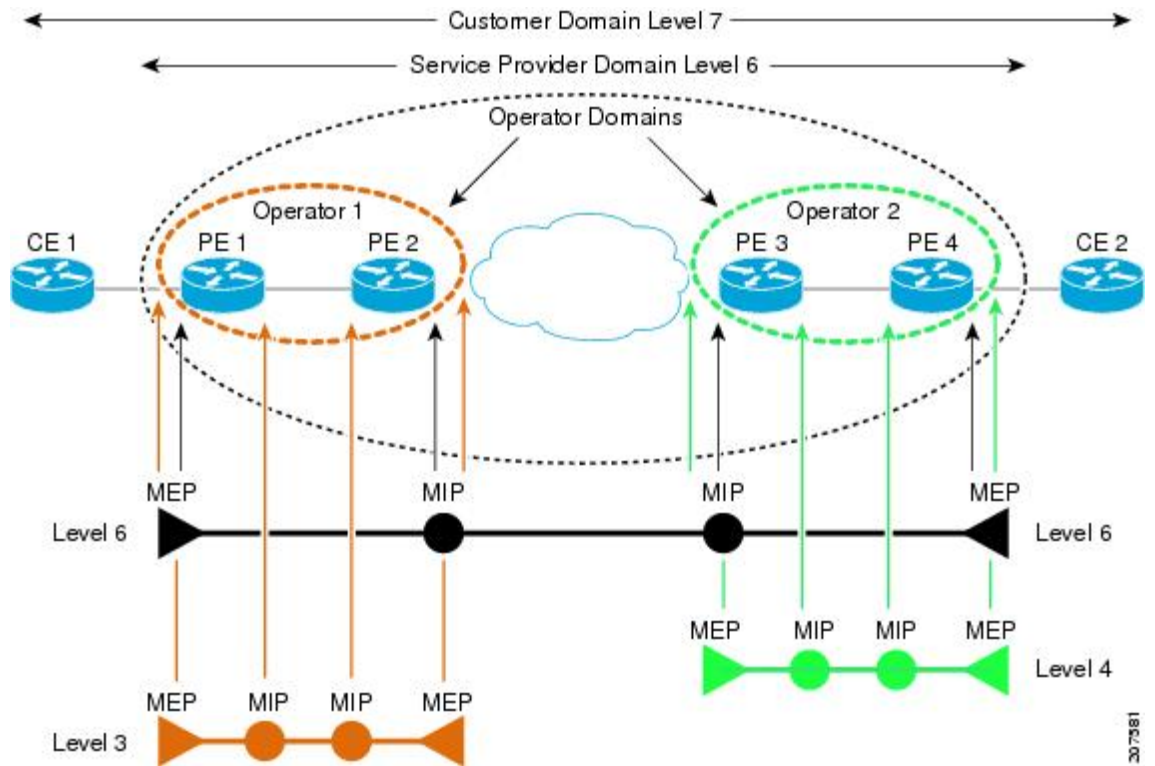
Each organization uses a different CFM maintenance domain.

This figure shows an example of the different levels of maintenance domains in a network.



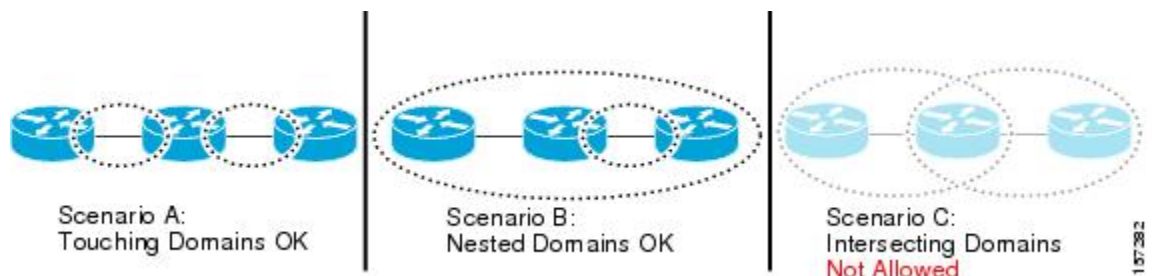
Note In CFM diagrams, the conventions are that triangles represent MEPs, pointing in the direction that the MEP sends CFM frames, and circles represent MIPs. For more information about MEPs and MIPs, see the “Maintenance Points” section on page 71.

Figure 3: Different CFM Maintenance Domains Across a Network



To ensure that the CFM frames for each domain do not interfere with each other, each domain is assigned a maintenance level, between 0 and 7. Where domains are nested, as in this example, the encompassing domain must have a higher level than the domain it encloses. In this case, the domain levels must be negotiated between the organizations involved. The maintenance level is carried in all CFM frames that relate to that domain.

CFM maintenance domains may touch or nest, but cannot intersect. This figure illustrates the supported structure for touching and nested domains, and the unsupported intersection of domains.



Services

A CFM service allows an organization to partition its CFM maintenance domain, according to the connectivity within the network. For example, if the network is divided into a number of virtual LANs (VLANs), a CFM service is created for each of these. CFM can then operate independently in each service. It is important that the CFM services match the network topology, so that CFM frames relating to one service cannot be received in a different service. For example, a service provider may use a separate CFM service for each of their customers, to verify and manage connectivity between that customer's end points.

A CFM service is always associated with the maintenance domain that it operates within, and therefore with that domain's maintenance level. All CFM frames relating to the service carry the maintenance level of the corresponding domain.



Note CFM Services are referred to as *Maintenance Associations* in IEEE 802.1ag and as *Maintenance Entity Groups* in ITU-T Y.1731.

Maintenance Points

A CFM Maintenance Point (MP) is an instance of a particular CFM service on a specific interface. CFM only operates on an interface if there is a CFM maintenance point on the interface; otherwise, CFM frames are forwarded transparently through the interface.

A maintenance point is always associated with a particular CFM service, and therefore with a particular maintenance domain at a particular level. Maintenance points generally only process CFM frames at the same level as their associated maintenance domain. Frames at a higher maintenance level are always forwarded transparently, while frames at a lower maintenance level are normally dropped. This helps enforce the maintenance domain hierarchy described in the [“Maintenance Domains” section on page 69](#), and ensures that CFM frames for a particular domain cannot leak out beyond the boundary of the domain.

There are two types of MP:

- Maintenance End Points (MEPs)—Created at the edge of the domain. Maintenance end points (MEPs) are members of a particular service within a domain and are responsible for sourcing and sinking CFM frames. They periodically transmit continuity check messages and receive similar messages from other MEPs within their domain. They also transmit traceroute and loopback messages at the request of the administrator. MEPs are responsible for confining CFM messages within the domain.
- Maintenance Intermediate Points (MIPs)—Created in the middle of the domain. Unlike MEPS, MIPs do allow CFM frames at their own level to be forwarded.

MIP Creation

Unlike MEPs, MIPs are not explicitly configured on each interface. MIPs are created automatically according to the algorithm specified in the CFM 802.1ag standard. The algorithm, in brief, operates as follows for each interface:

- The bridge-domain or cross-connect for the interface is found, and all services associated with that bridge-domain or cross-connect are considered for MIP auto-creation.
- The level of the highest-level MEP on the interface is found. From among the services considered above, the service in the domain with the lowest level that is higher than the highest MEP level is selected. If there are no MEPs on the interface, the service in the domain with the lowest level is selected.

- The MIP auto-creation configuration (**mip auto-create** command) for the selected service is examined to determine whether a MIP should be created.



Note Configuring a MIP auto-creation policy for a service does not guarantee that a MIP will automatically be created for that service. The policy is only considered if that service is selected by the algorithm first.

MEP and CFM Processing Overview

The boundary of a domain is an interface, rather than a bridge or host. Therefore, MEPs can be sub-divided into two categories:

- Down MEPs—Send CFM frames from the interface where they are configured, and process CFM frames received on that interface. Down MEPs transmit AIS messages upward (toward the cross-connect).
- Up MEPs—Send frames into the bridge relay function, as if they had been received on the interface where the MEP is configured. They process CFM frames that have been received on other interfaces, and have been switched through the bridge relay function as if they are going to be sent out of the interface where the MEP is configured. Up MEPs transmit AIS messages downward (toward the wire). However, AIS packets are only sent when there is a MIP configured on the same interface as the MEP and at the level of the MIP.

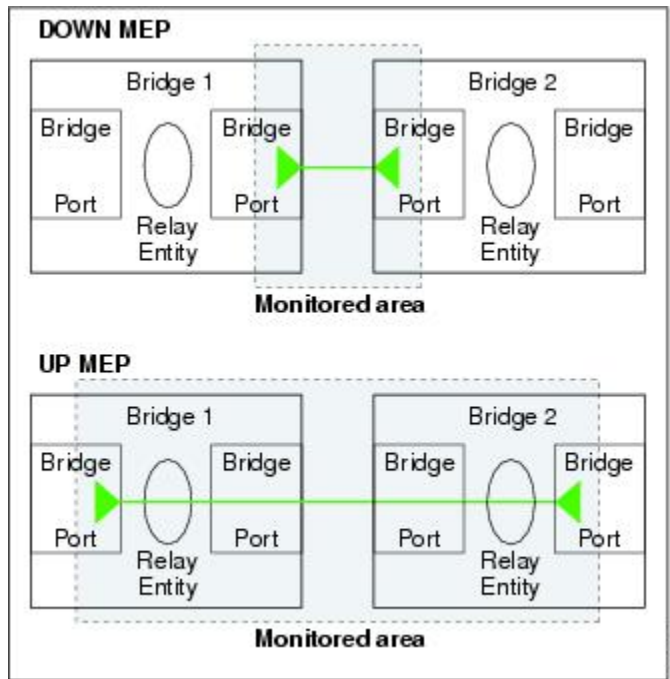


Note

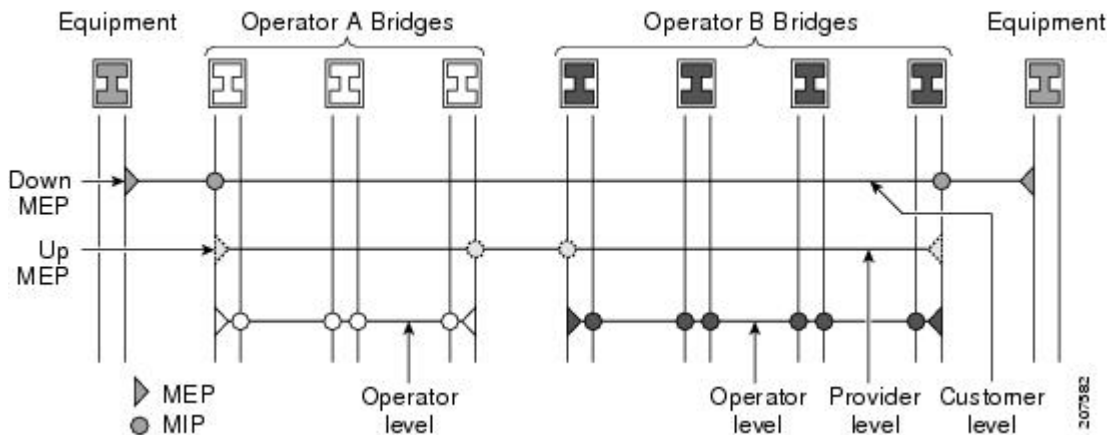
- The terms *Down MEP* and *Up MEP* are defined in the IEEE 802.1ag and ITU-T Y.1731 standards, and refer to the direction that CFM frames are sent from the MEP. The terms should not be confused with the operational status of the MEP.
 - NCS5500 only supports the “Down MEP level < Up MEP level” configuration.
-

This figure illustrates the monitored areas for Down and Up MEPs.

Figure 4: Monitored Areas for Down and Up MEPs



This figure shows maintenance points at different levels. Because domains are allowed to nest but not intersect (see), a MEP at a low level always corresponds with a MEP or MIP at a higher level. In addition, only a single MIP is allowed on any interface—this is generally created in the lowest domain that exists at the interface and that does not have a MEP.



MIPs and Up MEPs can only exist on switched (Layer 2) interfaces, because they send and receive frames from the bridge relay function. Down MEPs can be created on switched (Layer 2) or routed (Layer 3) interfaces.

MEPs continue to operate normally if the interface they are created on is blocked by the Spanning Tree Protocol (STP); that is, CFM frames at the level of the MEP continue to be sent and received, according to the direction of the MEP. MEPs never allow CFM frames at the level of the MEP to be forwarded, so the STP block is maintained.

MIPs also continue to receive CFM frames at their level if the interface is STP blocked, and can respond to any received frames. However, MIPs do not allow CFM frames at the level of the MIP to be forwarded if the interface is blocked.



Note A separate set of CFM maintenance levels is created every time a VLAN tag is pushed onto the frame. Therefore, if CFM frames are received on an interface which pushes an additional tag, so as to “tunnel” the frames over part of the network, the CFM frames will not be processed by any MPs within the tunnel, even if they are at the same level. For example, if a CFM MP is created on an interface with an encapsulation that matches a single VLAN tag, any CFM frames that are received at the interface that have two VLAN tags will be forwarded transparently, regardless of the CFM level.

CFM Protocol Messages

The CFM protocol consists of a number of different message types, with different purposes. All CFM messages use the CFM EtherType, and carry the CFM maintenance level for the domain to which they apply.

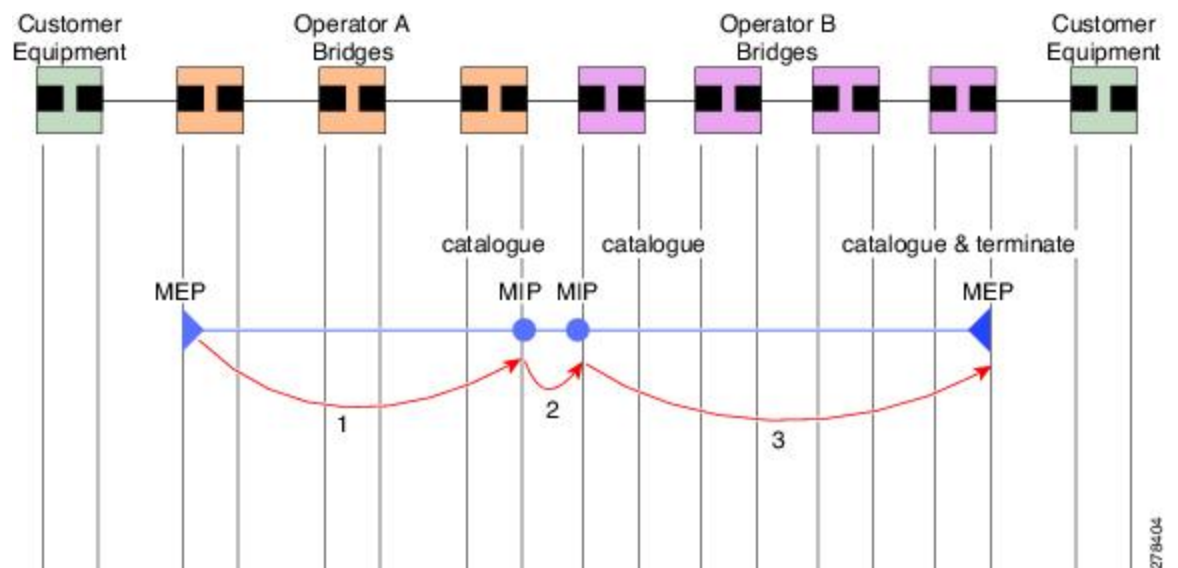
This section describes the following CFM messages:

Continuity Check (IEEE 802.1ag and ITU-T Y.1731)

Continuity Check Messages (CCMs) are “heartbeat” messages exchanged periodically between all the MEPs in a service. Each MEP sends out multicast CCMs, and receives CCMs from all the other MEPs in the service—these are referred to as *peer MEPs*. This allows each MEP to discover its peer MEPs, and to verify that there is connectivity between them.

MIPs also receive CCMs. MIPs use the information to build a MAC learning database that is used when responding to Linktrace. For more information about Linktrace, see the [Linktrace \(IEEE 802.1ag and ITU-T Y.1731\)](#).

Figure 5: Continuity Check Message Flow



All the MEPs in a service must transmit CCMs at the same interval. IEEE 802.1ag defines 7 possible intervals that can be used:

- 3.3ms
- 10ms
- 100ms
- 1s
- 10s
- 1 minute
- 10 minutes

A MEP detects a loss of connectivity with one of its peer MEPs when some number of CCMs have been missed. This occurs when sufficient time has passed during which a certain number of CCMs were expected, given the CCM interval. This number is called the *loss threshold*, and is usually set to 3.

CFM is supported only on interfaces which have Layer 2 transport feature enabled.

CCM messages carry a variety of information that allows different defects to be detected in the service. This information includes:

- A configured identifier for the domain of the transmitting MEP. This is referred to as the Maintenance Domain Identifier (MDID).
- A configured identifier for the service of the transmitting MEP. This is referred to as the Short MA Name (SMAN). Together, the MDID and the SMAN make up the Maintenance Association Identifier (MAID). The MAID must be configured identically on every MEP in the service.
- These are restrictions on the type of MAID that are supported for sessions with time interval of less than 1 minute. The MAID supports two types of formats on offloaded MEPs:
 - No Domain Name Format
 - MD Name Format = 1-NoDomainName
 - Short MA Name Format = 3 - 2 bytes integer value
 - Short MA Name Length = 2 - fixed length
 - Short MA Name = 2 bytes of integer
 - 1731 Maid Format
 - MD Name Format = 1-NoDomainName
 - MA Name Format(MEGID Format) = 32
 - MEGID Length = 13 - fixed length
 - MEGID(ICCCode) = 6 Bytes
 - MEGID(UMC) = 7 Bytes
 - ITU Carrier Code (ICC) - Number of different configurable ICC code - 15 (for each NPU)
 - Unique MEG ID Code (UMC) - 4

Maintenance Association Identifier (MAID) comprises of the Maintenance Domain Identifier (MDID) and Short MA Name (SMAN). MDID only supports **null** value and SMAN only supports ITU Carrier Code (ICC) or a numerical. No other values are supported.

An example for configuring domain ID null is: **ethernet cfm domain SMB level 3 id null**

An example for configuring SMAN is: **ethernet cfm domain SMB level 3 id null service 901234AB xconnect group 99999 p2p 99999 id number 1**

The following table summarizes the supported values and parameters for MDID and SMAN. This table only details the MAID restriction on the hardware offload feature. There is no MAID restriction for software offload or non-offloaded MEPs.

For Cisco NCS 5500 series routers, "id null" has to be explicitly configured for the domain ID, for hardware offloaded sessions.

Format	MDID	SMAN	Support	Comment
	No	2 byte integer	Yes	Up to 2000 entries
	No	13 bytes ICCCode (6 bytes) and UMC (7 bytes)	Yes	Up to 15 unique ICC Up to 4K UMC values
48 bytes string based	1-48 bytes of MDID and SMAN		No	Most commonly used

- A configured numeric identifier for the MEP (the MEP ID). Each MEP in the service must be configured with a different MEP ID.
- Dynamic Remote MEPs are not supported for MEPs with less than 1min interval. You must configure MEP CrossCheck for all such MEPS.
- Sequence numbering is not supported for MEPs with less than 1 minute interval.
- In a Remote Defect Indication (RDI), each MEP includes this in the CCMs it is sending, if it has detected a defect relating to the CCMs it is receiving. This notifies all the MEPs in the service that a defect has been detected somewhere in the service.
- The interval at which CCMs are being transmitted.
- CCM Tx/Rx statistics counters are not supported for MEPs with less than 1 minute intervals.
- Sender TLV and Cisco Proprietary TLVs are not supported for MEPs with less than 1min intervals.
- The status of the interface where the MEP is operating—for example, whether the interface is up, down, STP blocked, and so on.



Note The status of the interface (up/down) should not be confused with the direction of any MEPs on the interface (Up MEPs/Down MEPs).

These defects can be detected from received CCMs:

- Interval mismatch—The CCM interval in the received CCM does not match the interval that the MEP is sending CCMs.
- Level mismatch—A MEP has received a CCM carrying a lower maintenance level than the MEP's own level.
- Loop—A CCM is received with the source MAC address equal to the MAC address of the interface where the MEP is operating.
- Configuration error—A CCM is received with the same MEP ID as the MEP ID configured for the receiving MEP.
- Cross-connect—A CCM is received with an MAID that does not match the locally configured MAID. This generally indicates a VLAN misconfiguration within the network, such that CCMs from one service are leaking into a different service.
- Peer interface down—A CCM is received that indicates the interface on the peer is down.
- Remote defect indication—A CCM is received carrying a remote defect indication.



Note This defect does not cause the MEP to include a remote defect indication in the CCMs that it is sending.

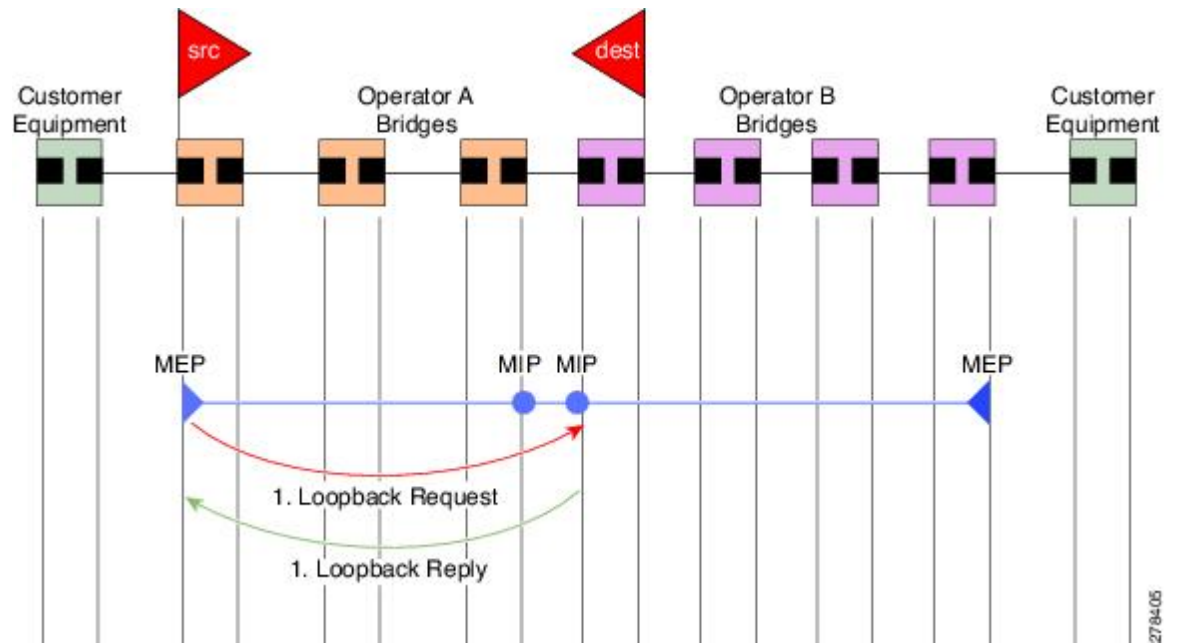
Out-of-sequence CCMs can also be detected by monitoring the sequence number in the received CCMs from each peer MEP. However, this is not considered a CCM defect.

Loopback (IEEE 802.1ag and ITU-T Y.1731)

Loopback Messages (LBM) and Loopback Replies (LBR) are used to verify connectivity between a local MEP and a particular remote MP. At the request of the administrator, a local MEP sends unicast LBMs to the remote MP. On receiving each LBM, the target maintenance point sends an LBR back to the originating MEP. Loopback indicates whether the destination is reachable or not—it does not allow hop-by-hop discovery of the path. It is similar in concept to an ICMP Echo (ping). Since loopback messages are destined for unicast addresses, they are forwarded like normal data traffic, while observing the maintenance levels. At each device that the loopback reaches, if the outgoing interface is known (in the bridge's forwarding database), then the frame is sent out on that interface. If the outgoing interface is not known, then the message is flooded on all interfaces.

This figure shows an example of CFM loopback message flow between a MEP and MIP.

Figure 6: Loopback Messages



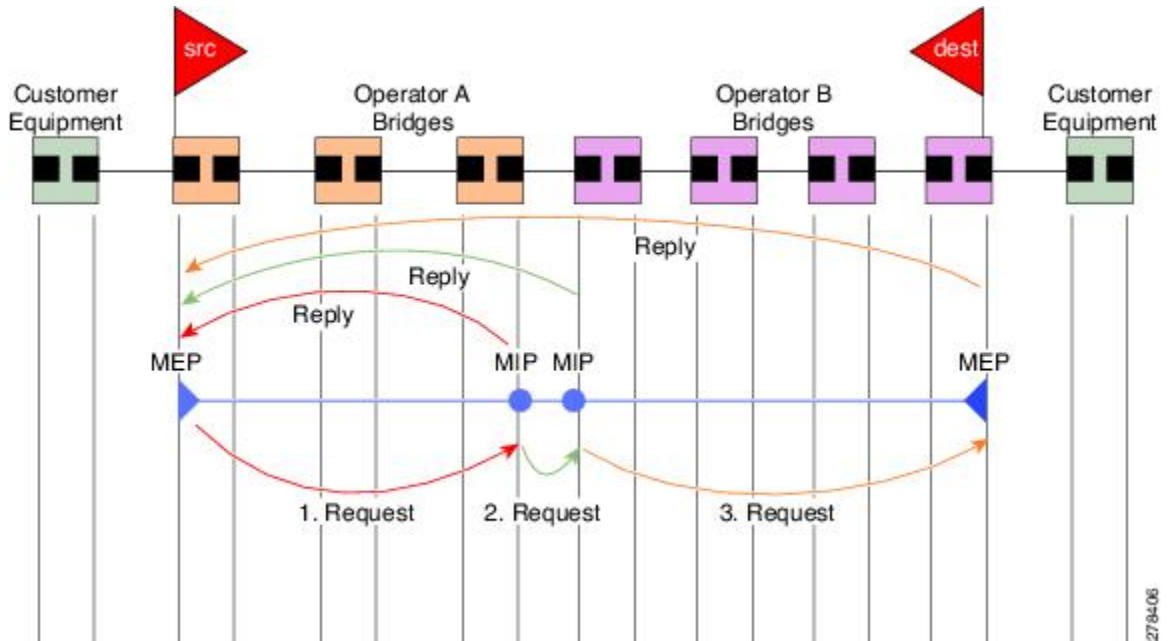
Loopback messages can be padded with user-specified data. This allows data corruption to be detected in the network. They also carry a sequence number which allows for out-of-order frames to be detected.

Linktrace (IEEE 802.1ag and ITU-T Y.1731)

Linktrace Messages (LTM) and Linktrace Replies (LTR) are used to track the path (hop-by-hop) to a unicast destination MAC address. At the request of the operator, a local MEP sends an LTM. Each hop where there is a maintenance point sends an LTR back to the originating MEP. This allows the administrator to discover connectivity data about the path. It is similar in concept to IP traceroute, although the mechanism is different. In IP traceroute, successive probes are sent, whereas CFM Linktrace uses a single LTM which is forwarded by each MP in the path. LTMs are multicast, and carry the unicast target MAC address as data within the frame. They are intercepted at each hop where there is a maintenance point, and either retransmitted or dropped to discover the unicast path to the target MAC address.

This figure shows an example of CFM linktrace message flow between MEPs and MIPs.

Figure 7: Linktrace Message Flow



The linktrace mechanism is designed to provide useful information even after a network failure. This allows it to be used to locate failures, for example after a loss of continuity is detected. To achieve this, each MP maintains a CCM Learning Database. This maps the source MAC address for each received CCM to the interface through which the CCM was received. It is similar to a typical bridge MAC learning database, except that it is based only on CCMs and it times out much more slowly—on the order of days rather than minutes.



Note In IEEE 802.1ag, the CCM Learning Database is referred to as the MIP CCM Database. However, it applies to both MIPs and MEPs.

In IEEE 802.1ag, when an MP receives an LTM message, it determines whether to send a reply using the following steps:

1. The target MAC address in the LTM is looked up in the bridge MAC learning table. If the MAC address is known, and therefore the egress interface is known, then an LTR is sent.
2. If the MAC address is not found in the bridge MAC learning table, then it is looked up in the CCM learning database. If it is found, then an LTR is sent.
3. If the MAC address is not found, then no LTR is sent (and the LTM is not forwarded).

If the target MAC has never been seen previously in the network, the linktrace operation will not produce any results.



Note IEEE 802.1ag and ITU-T Y.1731 define slightly different linktrace mechanisms. In particular, the use of the CCM learning database and the algorithm described above for responding to LTM messages are specific to IEEE 802.1ag. IEEE 802.1ag also specifies additional information that can be included in LTRs. Regardless of the differences, the two mechanisms are interoperable.

Configurable Logging

CFM supports logging of various conditions to syslog. Logging can be enabled independently for each service, and when the following conditions occur:

- New peer MEPs are detected, or loss of continuity with a peer MEP occurs.
- Changes to the CCM defect conditions are detected.
- Cross-check “missing” or “unexpected” conditions are detected.
- AIS condition detected (AIS messages received) or cleared (AIS messages no longer received).
- EFD used to shut down an interface, or bring it back up.

EFD

Ethernet Fault Detection (EFD) is a mechanism that allows Ethernet OAM protocols, such as CFM, to control the `line protocol` state of an interface.

Unlike many other interface types, Ethernet interfaces do not have a line protocol, whose state is independent from that of the interface. For Ethernet interfaces, this role is handled by the physical-layer Ethernet protocol itself, and therefore if the interface is physically up, then it is available and traffic can flow.

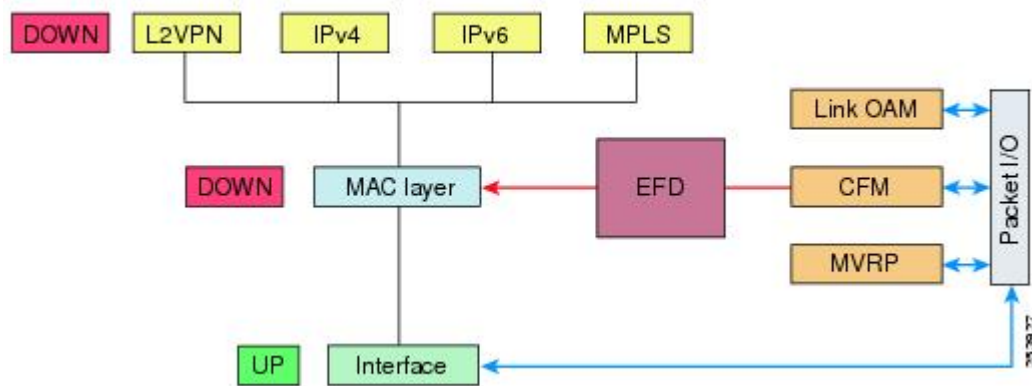
EFD changes this to allow CFM to act as the line protocol for Ethernet interfaces. This allows CFM to control the interface state so that if a CFM defect (such as AIS or loss of continuity) is detected with an expected peer MEP, the interface can be shut down. This not only stops traffic flow, but also triggers actions in any higher-level protocols to route around the problem. For example, in the case of Layer 2 interfaces, the MAC table would be cleared and MSTP would reconverge. For Layer 3 interfaces, the ARP cache would be cleared and potentially the IGP would reconverge.



Note EFD can only be used for down MEPs. When EFD is used to shut down the interface, the CFM frames continue to flow. This allows CFM to detect when the problem has been resolved, and thus bring the interface backup automatically.

This figure shows CFM detection of an error on one of its sessions EFD signaling an error to the corresponding MAC layer for the interface. This triggers the MAC to go to a down state, which further triggers all higher level protocols (Layer 2 pseudowires, IP protocols, and so on) to go down and also trigger a reconvergence where possible. As soon as CFM detects there is no longer any error, it can signal to EFD and all protocols will once again go active.

Figure 8: CFM Error Detection and EFD Trigger



Flexible VLAN Tagging for CFM

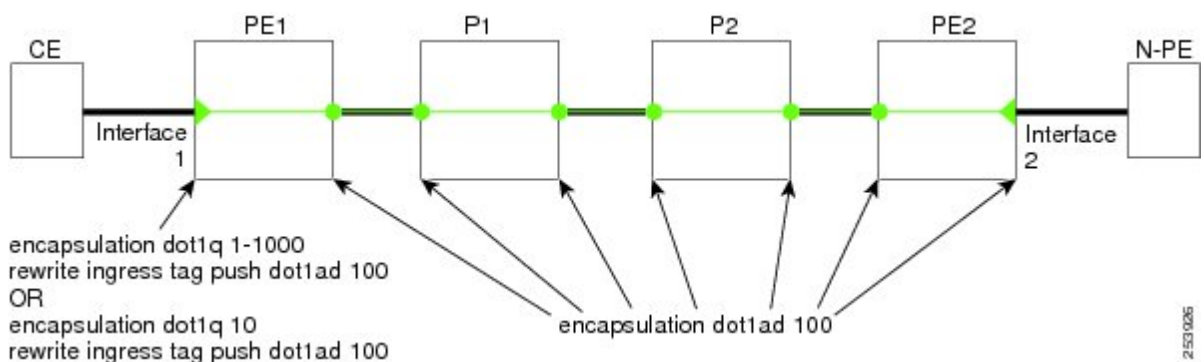
The Flexible VLAN Tagging for CFM feature ensures that CFM packets are sent with the right VLAN tags so that they are appropriately handled as a CFM packet by the remote device. When packets are received by an edge router, they are treated as either CFM packets or data packets, depending on the number of tags in the header. The system differentiates between CFM packets and data packets based on the number of tags in the packet, and forwards the packets to the appropriate paths based on the number of tags in the packet.

CFM frames are normally sent with the same VLAN tags as the corresponding customer data traffic on the interface, as defined by the configured encapsulation and tag rewrite operations. Likewise, received frames are treated as CFM frames if they have the correct number of tags as defined by the configured encapsulation and tag rewrite configuration, and are treated as data frames (that is, they are forwarded transparently) if they have more than this number of tags.

In most cases, this behavior is as desired, since the CFM frames are then treated in exactly the same way as the data traffic flowing through the same service. However, in a scenario where multiple customer VLANs are multiplexed over a single multipoint provider service (for example, N:1 bundling), a different behavior might be desirable.

This figure shows an example of a network with multiple VLANs using CFM.

Figure 9: Service Provider Network With Multiple VLANs and CFM



This figure shows a provider's access network, where the S-VLAN tag is used as the service delimiter. PE1 faces the customer, and PE2 is at the edge of the access network facing the core. N:1 bundling is used, so the interface encapsulation matches a range of C-VLAN tags. This could potentially be the full range, resulting in all:1 bundling. There is also a use case where only a single C-VLAN is matched, but the S-VLAN is nevertheless used as the service delimiter—this is more in keeping with the IEEE model, but limits the provider to 4094 services.

CFM is used in this network with a MEP at each end of the access network, and MIPs on the boxes within the network (if it is native Ethernet). In the normal case, CFM frames are sent by the up MEP on PE1 with two VLAN tags, matching the customer data traffic. This means that at the core interfaces and at the MEP on PE2, the CFM frames are forwarded as if they were customer data traffic, since these interfaces match only on the S-VLAN tag. So, the CFM frames sent by the MEP on PE1 are not seen by any of the other MIPs.

Flexible VLAN tagging changes the encapsulation for CFM frames that are sent and received at Up MEPs. Flexible VLAN tagging allows the frames to be sent from the MEP on PE1 with just the S-VLAN tag that represents the provider service. If this is done, the core interfaces will treat the frames as CFM frames and they will be seen by the MIPs and by the MEP on PE2. Likewise, the MEP on PE1 should handle received frames with only one tag, as this is what it will receive from the MEP on PE2.

To ensure that CFM packets from Up MEPs are routed to the appropriate paths successfully, tags may be set to a specific number in a domain service, using the **tags** command. Currently, tags can only be set to one (1).

CFM on MC-LAG

CFM on Multi-Chassis Link Aggregation Groups is supported in the following typical network environment:

- The customer edge (CE) device is a dual-homed device that is connected to two provider edge (PE) point-of-attachment (POA) devices. However, the dual-homed device operates without awareness of connectivity to multiple PEs.
- The two points of attachment at the PE form a redundancy group (RG), with one POA functioning as the active POA, and the other as the standby POA for the dual-homed device link.
- As with typical failover scenarios, if a failure occurs with the active POA, the standby POA takes over to retain the dual-homed device's connectivity to the network.

CFM on MC-LAG support can be qualified at two levels:

- CFM for the RG level—CFM context is per redundancy group and verifies connectivity for the entire RG.
- CFM for the POA level—CFM context is per point of attachment and verifies connectivity to a single POA.

Both levels of CFM support have certain restrictions and configuration guidelines that you must consider for successful implementation.

For more information about LAG, see the *Configuring Link Bundling* chapter in this guide.

RG-Level CFM

RG-level CFM is comprised of three areas of monitoring:

RG Downlink Monitoring

RG downlink monitoring uses CFM to verify connectivity between the dual-homed device and the RG.

To configure RG downlink monitoring, be sure that the following requirements are met:

- Down MEPs are configured on the bundle.
- Down MEPs on each POA are configured identically, using the same MEP ID and source MAC address.

This configuration has the following restrictions:

- The CCM loss time is greater than the failover time (typically 50 ms), due to the shortest CCM interval of 100 ms that is currently supported, which results in the shortest CCM loss time of 350 ms.

End-to-End Service Monitoring

End-to-end service monitoring uses CFM to verify the end-to-end service between the dual-homed devices.

To configure end-to-end service monitoring, be sure that the following requirements are met:

- A down MEP is configured on the dual-homed device bundle interface or bundle subinterface.
- If optional MIPs are configured, then each POA is configured with a MIP on the bundle.
- Each POA can have a MIP on the uplink interface (if native Ethernet is used).
- The active and standby POA is configured identically.

This configuration has the following restrictions:

- The MIP on the standby POA will not respond to loopback or linktrace requests.

POA-Level CFM

POA-level monitoring uses CFM to verify connectivity between the dual-homed device and a single POA.

To configure POA-level CFM, be sure that these requirements are met:

- Down MEPs are configured on bundle members only.

This configuration has these restrictions:

- POA-level monitoring is not supported on uplinks between a single POA and the core.

Supported Features for CFM on MC-LAG

CFM on MC-LAG supports these CFM features:

- All existing IEEE 802.1ag and Y.1731 functionality is supported on an MC-LAG RG.
- CFM maintenance points are supported on an MC-LAG interface. Maintenance points on a standby link are put into standby state.
- Maintenance points in standby state receive CFM messages, but do not send or reply to any CFM messages.
- When a MEP transitions from active to standby, all CCM defects and alarms are cleared.
- Standby MEPs record remote MEP errors and timeouts, but do not report faults. This means that remote MEPs and their errors will appear in **show** commands, but no logs, alarms, MIB traps, or EFD are triggered and AIS messages are not sent.

- When a MEP transitions from standby to active, any CCM defects previously detected while the MEP was in standby are reapplied and immediate actions are taken (logs, alarms, MIB traps, EFD, and so on).

Restrictions for CFM on MC-LAG

To support CFM on MC-LAG, you must consider these restrictions and requirements:

- The CFM configuration must be the same on both the active and standby POAs.
- The CFM state is not synchronized between the two POAs. This can lead to flapping of the interface line protocol state on POA failover if EFD is configured. Fault alarms might also be delayed if a failover occurs just after a fault has been detected.
- POA-level CFM monitoring is not supported on a native Ethernet uplink interface.
- MEPs on bundle interfaces at level 0 are not supported.
- Loopback, linktrace, and Y.1731 SLA operations cannot be started from a MEP in standby state.
- Checks for configuration consistency of MEP IDs to ensure identical configuration of POAs is not supported.
- Y.1731 SLA statistics can be split between the two POAs if a failover occurs. An external network management system would need to collect and collate these statistics from the two POAs.

How to Configure Ethernet OAM

This section provides these configuration procedures:

Configuring Ethernet CFM

To configure Ethernet CFM, perform the following tasks:



Note CFM is not supported for the following:

- L3 Interfaces and Sub-Interfaces
 - Bundle Member Ports
 - EVPN-FXC
 - Bridge Domain
 - VPLS
-

Configuring a CFM Maintenance Domain

To configure a CFM maintenance domain, perform the following steps:

SUMMARY STEPS

1. **configure**
2. **ethernet cfm**
3. **domain** *domain-name level level-value* [**id** [null] [**dns** *DNS-name*] [**mac** *H.H.H*] [**string** *string*]]
4. **traceroute cache hold-time** *minutes size entries*
5. **end** or **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	ethernet cfm Example: RP/0/RP0/CPU0:router(config)# ethernet cfm	Enters Ethernet Connectivity Fault Management (CFM) configuration mode.
Step 3	domain <i>domain-name level level-value</i> [id [null] [dns <i>DNS-name</i>] [mac <i>H.H.H</i>] [string <i>string</i>]] Example: RP/0/RP0/CPU0:router(config-cfm)# domain Domain_One level 1 id string D1	Creates and names a container for all domain configurations and enters CFM domain configuration mode. The level must be specified. The id is the maintenance domain identifier (MDID) and is used as the first part of the maintenance association identifier (MAID) in CFM frames. If the MDID is not specified, the domain name is used as the MDID by default.
Step 4	traceroute cache hold-time <i>minutes size entries</i> Example: RP/0/RP0/CPU0:router(config-cfm)# traceroute cache hold-time 1 size 3000	(Optional) Sets the maximum limit of traceroute cache entries or the maximum time limit to hold the traceroute cache entries. The default is 100 minutes and 100 entries.
Step 5	end or commit Example: RP/0/RP0/CPU0:router(config-cfm-dmn)# commit	Saves configuration changes. <ul style="list-style-type: none"> • When you use the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]: • Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. • Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes.

	Command or Action	Purpose
		<ul style="list-style-type: none"> • Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. • Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring Services for a CFM Maintenance Domain

You can configure up to 32000 CFM services for a maintenance domain. To configure services for a CFM maintenance domain, perform the following steps:

SUMMARY STEPS

1. **configure**
2. **ethernet cfm**
3. **domain** *domain-name* **level** *level-value* [**id** [null] [**dns** *DNS-name*] [**mac** *H.H.H*] [**string** *string*]]
4. **service** *service-name* {**down-meps** | **xconnect group** *xconnect-group-name* **p2p** *xconnect-name*} [**id** [**icc-based** *icc-string* *umc-string*] | [**number** *number*]
5. **end** or **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# <code>configure</code>	Enters global configuration mode.
Step 2	ethernet cfm Example: RP/0/RP0/CPU0:router(config)# <code>ethernet cfm</code>	Enters Ethernet CFM configuration mode.
Step 3	domain <i>domain-name</i> level <i>level-value</i> [id [null] [dns <i>DNS-name</i>] [mac <i>H.H.H</i>] [string <i>string</i>]] Example: RP/0/RP0/CPU0:router(config-cfm)# <code>domain Domain_One level 1 id string D1</code>	Creates and names a container for all domain configurations at a specified maintenance level, and enters CFM domain configuration mode. The id is the maintenance domain identifier (MDID) and is used as the first part of the maintenance association identifier (MAID) in CFM frames. If the MDID is not specified, the domain name is used as the MDID by default.
Step 4	service <i>service-name</i> { down-meps xconnect group <i>xconnect-group-name</i> p2p <i>xconnect-name</i> } [id [icc-based <i>icc-string</i> <i>umc-string</i>] [number <i>number</i>]	Configures and associates a service with the domain and enters CFM domain service configuration mode. You can specify that the service is used only for down MEPs, or

	Command or Action	Purpose
	<p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-cfm-dmn)# service xconnect group X1</pre>	<p>associate the service with a bridge domain where MIPs and up MEPs will be created.</p> <p>The id sets the short MA name.</p>
Step 5	<p>end or commit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you use the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Enabling and Configuring Continuity Check for a CFM Service

To configure Continuity Check for a CFM service, complete the following steps:

SUMMARY STEPS

- configure**
- ethernet cfm**
- domain** *domain-name* **level** *level-value* [**id** [null] [**dns** *DNS-name*] [**mac** *H.H.H*] [**string** *string*]]
- service** *service-name* {**down-meps** | **xconnect group** *xconnect-group-name* **p2p** *xconnect-name*} [**id** [**icc-based** *icc-string umc-string*] | [**number** *number*]
- continuity-check interval** *time* [**loss-threshold** *threshold*]
- continuity-check archive hold-time** *minutes*
- continuity-check loss auto-traceroute**
- end or commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	ethernet cfm Example: RP/0/RP0/CPU0:router(config)# ethernet cfm	Enters Ethernet Connectivity Fault Management (CFM) configuration mode.
Step 3	domain domain-name level level-value [id [null]] [dns DNS-name] [mac H.H.H] [string string]] Example: RP/0/RP0/CPU0:router(config-cfm)# domain Domain_One level 1 id string D1	Creates and names a container for all domain configurations and enters the CFM domain configuration mode. The level must be specified. The id is the maintenance domain identifier (MDID) and is used as the first part of the maintenance association identifier (MAID) in CFM frames. If the MDID is not specified, the domain name is used as the MDID by default.
Step 4	service service-name {down-meps xconnect group xconnect-group-name p2p xconnect-name} [id [icc-based icc-string umc-string] [number number] Example: RP/0/RP0/CPU0:router(config-cfm-dmn)# service xconnect group X1	Configures and associates a service with the domain and enters CFM domain service configuration mode. You can specify that the service is used only for down MEPs, or associate the service with a bridge domain or xconnect where MIPs and up MEPs will be created. The id sets the short MA name.
Step 5	continuity-check interval time [loss-threshold threshold] Example: RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# continuity-check interval 100m loss-threshold 10	(Optional) Enables Continuity Check and specifies the time interval at which CCMs are transmitted or to set the threshold limit for when a MEP is declared down.
Step 6	continuity-check archive hold-time minutes Example: RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# continuity-check archive hold-time 100	(Optional) Configures how long information about peer MEPs is stored after they have timed out.
Step 7	continuity-check loss auto-traceroute Example: RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# continuity-check loss auto-traceroute	(Optional) Configures automatic triggering of a traceroute when a MEP is declared down.
Step 8	end or commit Example:	Saves configuration changes.

	Command or Action	Purpose
	<pre>RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# commit</pre>	<ul style="list-style-type: none"> When you use the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]: Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring Automatic MIP Creation for a CFM Service

For more information about the algorithm for creating MIPs, see the **MIP Creation** section.

To configure automatic MIP creation for a CFM service, complete the following steps:

SUMMARY STEPS

- configure**
- ethernet cfm**
- domain** *domain-name* **level** *level-value* [**id** [null] [**dns** *DNS-name*] [**mac** *H.H.H*] [**string** *string*]]
- service** *service-name* {**down-meps** | **xconnect group** *xconnect-group-name* **p2p** *xconnect-name*} [**id** [**icc-based***icc-string umc-string*] | [**number** *number*]
- mip auto-create** {**all** | **lower-mep-only**} {**ccm-learning**}
- end** or **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: <pre>RP/0/RP0/CPU0:router# configure</pre>	Enters global configuration mode.
Step 2	ethernet cfm Example:	Enters the Ethernet Connectivity Fault Management (CFM) configuration mode.

	Command or Action	Purpose
	RP/0/RP0/CPU0:router# ethernet cfm	
Step 3	<p>domain <i>domain-name</i> level <i>level-value</i> [id [null]] [dns <i>DNS-name</i>] [mac <i>H.H.H</i>] [string <i>string</i>]]</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-cfm)# domain Domain_One level 1 id string D1</pre>	<p>Creates and names a container for all domain configurations and enters the CFM domain configuration mode.</p> <p>The level must be specified. The only supported option is id [null] for less than 1min interval MEPS.</p> <p>The id is the maintenance domain identifier (MDID) and is used as the first part of the maintenance association identifier (MAID) in CFM frames. If the MDID is not specified, the domain name is used as the MDID by default.</p>
Step 4	<p>service <i>service-name</i> {down-meps xconnect group <i>xconnect-group-name</i> p2p <i>xconnect-name</i>} [id [icc-based<i>icc-string</i> <i>umc-string</i>] [number <i>number</i>]</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-cfm-dmn)# service xconnect group X1</pre>	<p>Configures and associates a service with the domain and enters CFM domain service configuration mode. You can specify that the service is used only for down MEPS, or associate the service with a bridge domain where MIPs and up MEPS will be created.</p> <p>The id sets the short MA name.</p>
Step 5	<p>mip auto-create {all lower-mep-only} {ccm-learning}</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# mip auto-create all ccm-learning</pre>	<p>(Optional) Enables the automatic creation of MIPs in a bridge domain. ccm-learning option enables CCM learning for MIPs created in this service. This must be used only in services with a relatively long CCM interval of at least 100 ms. CCM learning at MIPs is disabled by default.</p>
Step 6	<p>end or commit</p> <p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you use the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring Cross-Check on a MEP for a CFM Service

To configure cross-check on a MEP for a CFM service and specify the expected set of MEPs, complete the following steps:

SUMMARY STEPS

1. **configure**
2. **ethernet cfm**
3. **domain** *domain-name* **level** *level-value* [**id** [null] [**dns** *DNS-name*] [**mac** *H.H.H*] [**string** *string*]]
4. **service** *service-name* {**bridge group** *bridge-domain-group* **bridge-domain** *bridge-domain-name* | **down-meps** | **xconnect group** *xconnect-group-name* **p2p** *xconnect-name*} [**id** [**icc-based** *icc-string umc-string*] | [**string** *text*] | [**number** *number*] | [**vlan-id** *id-number*] | [**vpn-id** *oui-vpnid*]]
5. **mep crosscheck**
6. **mep-id** *mep-id-number* [**mac-address** *mac-address*]
7. **end** or **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	ethernet cfm Example: RP/0/RP0/CPU0:router# ethernet cfm	Enters the Ethernet Connectivity Fault Management (CFM) configuration mode.
Step 3	domain <i>domain-name</i> level <i>level-value</i> [id [null] [dns <i>DNS-name</i>] [mac <i>H.H.H</i>] [string <i>string</i>]] Example: RP/0/RP0/CPU0:router(config-cfm)# domain Domain_One level 1 id string D1	Creates and names a container for all domain configurations and enters the CFM domain configuration mode. The level must be specified. The id is the maintenance domain identifier (MDID) and is used as the first part of the maintenance association identifier (MAID) in CFM frames. If the MDID is not specified, the domain name is used as the MDID by default.
Step 4	service <i>service-name</i> { bridge group <i>bridge-domain-group</i> bridge-domain <i>bridge-domain-name</i> down-meps xconnect group <i>xconnect-group-name</i> p2p <i>xconnect-name</i> } [id [icc-based <i>icc-string umc-string</i>] [string <i>text</i>] [number <i>number</i>] [vlan-id <i>id-number</i>] [vpn-id <i>oui-vpnid</i>]] Example: RP/0/RP0/CPU0:router(config-cfm-dmn)# service Bridge_Service bridge group B1 bridge-domain B1	Configures and associates a service with the domain and enters CFM domain service configuration mode. You can specify that the service is used only for down MEPs, or associate the service with a bridge domain or xconnect where MIPs and up MEPs will be created. The id sets the short MA name.

	Command or Action	Purpose
Step 5	mep crosscheck Example: <pre>RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# mep crosscheck mep-id 10</pre>	Enters CFM MEP crosscheck configuration mode.
Step 6	mep-id <i>mep-id-number</i> [<i>mac-address mac-address</i>] Example: <pre>RP/0/RP0/CPU0:router(config-cfm-xcheck)# mep-id 10</pre>	Enables cross-check on a MEP. Note <ul style="list-style-type: none"> Repeat this command for every MEP that you want included in the expected set of MEPs for cross-check.
Step 7	end or commit Example: <pre>RP/0/RP0/CPU0:router(config-cfm-xcheck)# commit</pre>	Saves configuration changes. <ul style="list-style-type: none"> When you use the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</pre> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring Other Options for a CFM Service

To configure other options for a CFM service, complete the following steps:

SUMMARY STEPS

1. **configure**
2. **ethernet cfm**
3. **domain *domain-name* level *level-value* [*id* [*null*] [*dns* *DNS-name*] [*mac* *H.H.H*] [*string* *string*]**]
4. **service *service-name* {**bridge group** *bridge-domain-group* **bridge-domain** *bridge-domain-name* | **down-meps** | **xconnect group** *xconnect-group-name* **p2p** *xconnect-name*} [*id* [*icc-based* *icc-string* *umc-string*] | [*string* *text*] | [*number* *number*] | [*vlan-id* *id-number*] | [*vpn-id* *oui-vpnid*]**
5. **maximum-meps *number***

6. `log {ais|continuity-check errors|continuity-check mep changes|crosscheck errors|efd}`
7. `end` or `commit`

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	ethernet cfm Example: RP/0/RP0/CPU0:router# ethernet cfm	Enters the Ethernet Connectivity Fault Management (CFM) configuration mode.
Step 3	domain <i>domain-name</i> level <i>level-value</i> [id [null] [dns <i>DNS-name</i>] [mac <i>H.H.H</i>] [string <i>string</i>]] Example: RP/0/RP0/CPU0:router(config-cfm)# domain Domain_One level 1 id string D1	<p>Creates and names a container for all domain configurations and enters the CFM domain configuration mode.</p> <p>The level must be specified.</p> <p>The id is the maintenance domain identifier (MDID) and is used as the first part of the maintenance association identifier (MAID) in CFM frames. If the MDID is not specified, the domain name is used as the MDID by default.</p>
Step 4	service <i>service-name</i> { bridge group <i>bridge-domain-group</i> bridge-domain <i>bridge-domain-name</i> down-meps xconnect group <i>xconnect-group-name</i> p2p <i>xconnect-name</i> } [id [icc-based <i>icc-string umc-string</i>] [string <i>text</i>] [number <i>number</i>] [vlan-id <i>id-number</i>] [vpn-id <i>oui-vpnid</i>]] Example: RP/0/RP0/CPU0:router(config-cfm-dmn)# service Bridge_Service bridge group B1 bridge-domain B1	<p>Configures and associates a service with the domain and enters CFM domain service configuration mode. You can specify that the service is used only for down MEPS, or associate the service with a bridge domain or xconnect where MIPs and up MEPS will be created.</p> <p>The id sets the short MA name.</p>
Step 5	maximum-meps <i>number</i> Example: RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# maximum-meps 1000	(Optional) Configures the maximum number (2 to 8190) of MEPS across the network, which limits the number of peer MEPS recorded in the database.
Step 6	log {ais continuity-check errors continuity-check mep changes crosscheck errors efd} Example: RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# log continuity-check errors	(Optional) Enables logging of certain types of events.
Step 7	end or commit	Saves configuration changes.

	Command or Action	Purpose
	<p>Example:</p> <pre>RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# commit</pre>	<ul style="list-style-type: none"> • When you use the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> • Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. • Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. • Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. • Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring CFM MEPs

When you configure CFM MEPs, consider these guidelines:

- CFM is supported on Cisco NCS 5001 and Cisco NCS 5002 Series routers only.
- Up to 672 (84 physical interfaces*8 levels) local MEPs are supported per card.
- CFM maintenance points can be created only on physical Ethernet interfaces.
- CFM maintenance points can be created on these interface types:
 - All physical Ethernet interfaces (except for the RSP Management interfaces).
 - Ethernet bundle interfaces.
 - Ethernet bundle member interfaces—Only down MEPs at level 0 can be created.
- CFM maintenance points can be created on both Layer 2 and Layer 3 interfaces. On L3 interfaces, only down MEPs can be created.
- Up MEPs are not supported.
- CCM packet must not go through L3VPN cloud.
- LBM/LBR packet must not go through L3VPN cloud.
- LTM/LTR packet must not go through L3VPN cloud.

SUMMARY STEPS

1. **configure**
2. **interface** {**HundredGigE** | **TenGigE**} *interface-path-id*
3. **interface** {**HundredGigE** | **TenGigE** | **Bundle-Ether**} *interface-path-id.subinterface*
4. **vrf vrf-name**
5. **interface** {**HundredGigE** | **TenGigE**} *interface-path-id*
6. **ethernet cfm**
7. **mep domain** *domain-name* **service** *service-name* **mep-id** *id-number*
8. **cos** *cos*
9. **end** or **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface { HundredGigE TenGigE } <i>interface-path-id</i> Example: RP/0/RP0/CPU0:router(config)# interface TenGigE 0/0/0/1	Type of Ethernet interface on which you want to create a MEP. Enter HundredGigE or TenGigE and the physical interface or virtual interface. Note <ul style="list-style-type: none"> • Use the show interfaces command to see a list of all interfaces currently configured on the router.
Step 3	interface { HundredGigE TenGigE Bundle-Ether } <i>interface-path-id.subinterface</i> Example: RP/0/RP0/CPU0:router(config)# interface TenGigE 0/0/0/1	Type of Ethernet interface on which you want to create a MEP. Enter HundredGigE , TenGigE , or Bundle-Ether and the physical interface or virtual interface followed by the subinterface path ID. Naming convention is <i>interface-path-id.subinterface</i> . The period in front of the subinterface value is required as part of the notation.
Step 4	vrf vrf-name Example: RP/0/RP0/CPU0:router(config-if)# vrf vrf_A	Configures a VRF instance and enters VRF configuration mode.
Step 5	interface { HundredGigE TenGigE } <i>interface-path-id</i> Example: RP/0/RP0/CPU0:router(config)# interface TenGigE 0/0/0/1	Type of Ethernet interface on which you want to create a MEP. Enter HundredGigE or TenGigE and the physical interface or virtual interface. Note <ul style="list-style-type: none"> • Use the show interfaces command to see a list of all interfaces currently configured on the router.

	Command or Action	Purpose
Step 6	ethernet cfm Example: <pre>RP/0/RP0/CPU0:router(config-if)# ethernet cfm</pre>	Enters interface Ethernet CFM configuration mode.
Step 7	mep domain <i>domain-name</i> service <i>service-name</i> mep-id <i>id-number</i> Example: <pre>RP/0/RP0/CPU0:router(config-if-cfm)# mep domain Dm1 service Sv1 mep-id 1</pre>	Creates a maintenance end point (MEP) on an interface and enters interface CFM MEP configuration mode.
Step 8	cos <i>cos</i> Example: <pre>RP/0/RP0/CPU0:router(config-if-cfm-mep)# cos 7</pre>	<p>(Optional) Configures the class of service (CoS) (from 0 to 7) for all CFM packets generated by the MEP on an interface. If not configured, the CoS is inherited from the Ethernet interface.</p> <p>Note For Ethernet interfaces, the CoS is carried as a field in the VLAN tag. Therefore, CoS only applies to interfaces where packets are sent with VLAN tags. If the cos (CFM) command is executed for a MEP on an interface that does not have a VLAN encapsulation configured, it will be ignored.</p>
Step 9	end or commit Example: <pre>RP/0/RP0/CPU0:router(config-if-cfm-mep)# commit</pre>	<p>Saves configuration changes.</p> <ul style="list-style-type: none"> When you use the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring Y.1731 AIS

This section has the following step procedures:

Configuring AIS in a CFM Domain Service

Use the following procedure to configure Alarm Indication Signal (AIS) transmission for a CFM domain service and configure AIS logging.

SUMMARY STEPS

1. **configure**
2. **ethernet cfm**
3. **domain name level level**
4. **service name bridge group name bridge-domain name**
5. **service name xconnect group xconnect-group-name p2p xconnect-name**
6. **ais transmission [interval {1s|1m}][cos cos]**
7. **log ais**
8. **end or commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	ethernet cfm Example: RP/0/RP0/CPU0:router(config)# ethernet cfm	Enters Ethernet CFM global configuration mode.
Step 3	domain name level level Example: RP/0/RP0/CPU0:router(config-cfm)# domain D1 level 1	Specifies the domain and domain level.
Step 4	service name bridge group name bridge-domain name Example: RP/0/RP0/CPU0:router(config-cfm-dmn)# service S1 bridge group BG1 bridge-domain BD2	Specifies the service, bridge group, and bridge domain.
Step 5	service name xconnect group xconnect-group-name p2p xconnect-name Example:	Specifies the service and cross-connect group and name.

	Command or Action	Purpose
	RP/0/RP0/CPU0:router(config-cfm-dmn)# service S1 bridge group BG1 bridge-domain BD2	
Step 6	ais transmission [interval {1s 1m}][cos cos] Example: RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# ais transmission interval 1m cos 7	Configures Alarm Indication Signal (AIS) transmission for a Connectivity Fault Management (CFM) domain service.
Step 7	log ais Example: RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# log ais	Configures AIS logging for a Connectivity Fault Management (CFM) domain service to indicate when AIS or LCK packets are received.
Step 8	end or commit Example: RP/0/RP0/CPU0:router(config-sla-prof-stat-cfg)# commit	Saves configuration changes. <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring AIS on a CFM Interface

To configure AIS on a CFM interface, perform the following steps:

SUMMARY STEPS

1. **configure**
2. **interface gigabitethernet *interface-path-id***
3. **ethernet cfm**
4. **ais transmission up interval 1m cos *cos***
5. **end or commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	interface gigabitethernet <i>interface-path-id</i> Example: RP/0/RP0/CPU0:router# interface TenGigE 0/0/0/2	Enters interface configuration mode.
Step 3	ethernet cfm Example: RP/0/RP0/CPU0:router(config)# ethernet cfm	Enters Ethernet CFM interface configuration mode.
Step 4	ais transmission up interval 1m cos <i>cos</i> Example: RP/0/RP0/CPU0:router(config-if-cfm)# ais transmission up interval 1m cos 7	Configures Alarm Indication Signal (AIS) transmission on a Connectivity Fault Management (CFM) interface.
Step 5	end or commit Example: RP/0/RP0/CPU0:router(config-sla-prof-stat-cfg)# commit	Saves configuration changes. <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]: Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring EFD for a CFM Service

To configure EFD for a CFM service, complete the following steps.

SUMMARY STEPS

1. **configure**
2. **ethernet cfm**
3. **domain** *domain-name* **level** *level-value*
4. **service** *service-name* **down-meps**
5. **efd**
6. **log efd**
7. **end** or **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	ethernet cfm Example: RP/0/RP0/CPU0:router(config)# ethernet cfm	Enters CFM configuration mode.
Step 3	domain <i>domain-name</i> level <i>level-value</i> Example: RP/0/RP0/CPU0:router(config-cfm-dmn)# domain D1 level 1	Specifies or creates the CFM domain and enters CFM domain configuration mode.
Step 4	service <i>service-name</i> down-meps Example: RP/0/RP0/CPU0:router(config-cfm-dmn)# service S1 down-meps	Specifies or creates the CFM service for down MEPS and enters CFM domain service configuration mode.
Step 5	efd Example: RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# efd	Enables EFD on all down MEPs in the down MEPS service.
Step 6	log efd Example: RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# log efd	(Optional) Enables logging of EFD state changes on an interface.
Step 7	end or commit Example: RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# commit	Saves configuration changes. • When you issue the end command, the system prompts you to commit changes:

	Command or Action	Purpose
		<p>Uncommitted changes found, commit them before exiting (yes/no/cancel)? [cancel]:</p> <ul style="list-style-type: none"> • Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. • Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. • Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes. • Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Verifying the EFD Configuration

This example shows how to display all interfaces that are shut down because of Ethernet Fault Detection (EFD):

```
RP/0/RP0/CPU0:router# show efd interfaces

Server VLAN MA
=====
Interface      Clients
-----
TenGigE0/0/0/0.0    CFM
```

Configuring Flexible VLAN Tagging for CFM

Use this procedure to set the number of tags in CFM packets in a CFM domain service.

SUMMARY STEPS

1. **configure**
2. **ethernet cfm**
3. **domain name level level**
4. **service name bridge group name bridge-domain name**
5. **tags number**
6. **end** or **commit**

DETAILED STEPS

	Command or Action	Purpose
Step 1	configure Example: RP/0/RP0/CPU0:router# configure	Enters global configuration mode.
Step 2	ethernet cfm Example: RP/0/RP0/CPU0:router(config)# ethernet cfm	Enters Ethernet CFM global configuration mode.
Step 3	domain <i>name level level</i> Example: RP/0/RP0/CPU0:router(config-cfm)# domain D1 level 1	Specifies the domain and domain level.
Step 4	service <i>name</i> bridge group <i>name</i> bridge-domain <i>name</i> Example: RP/0/RP0/CPU0:router(config-cfm-dmn)# service S2 bridge group BG1 bridge-domain BD2	Specifies the service, bridge group, and bridge domain.
Step 5	tags <i>number</i> Example: RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# tags 1	Specifies the number of tags in CFM packets. Currently, the only valid value is 1.
Step 6	end or commit Example: RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# commit	Saves configuration changes. <ul style="list-style-type: none"> When you issue the end command, the system prompts you to commit changes: <pre>Uncommitted changes found, commit them before exiting(yes/no/cancel)? [cancel]:</pre> Entering yes saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode. Entering no exits the configuration session and returns the router to EXEC mode without committing the configuration changes. Entering cancel leaves the router in the current configuration session without exiting or committing the configuration changes.

	Command or Action	Purpose
		<ul style="list-style-type: none"> Use the commit command to save the configuration changes to the running configuration file and remain within the configuration session.

Verifying the CFM Configuration

To verify the CFM configuration, use one or more of the following commands:

show ethernet cfm configuration-errors [domain <i>domain-name</i>] [<i>interface interface-path-id</i>]	Displays information about errors that are preventing configured CFM operations from becoming active, as well as any warnings that have occurred.
show ethernet cfm local maintenance-points domain <i>name</i> [<i>service name</i>] <i>interface type interface-path-id</i> [mep mip]	Displays a list of local maintenance points.



Note After you configure CFM, the error message, *cmd[317]: %L2-CFM-5-CCM_ERROR_CCMS_MISSED : Some received CCMs have not been counted by the CCM error counters*, may display. This error message does not have any functional impact and does not require any action from you.

Troubleshooting Tips

To troubleshoot problems within the CFM network, perform these steps:

SUMMARY STEPS

- To verify connectivity to a problematic MEP, use the **ping ethernet cfm** command as shown in this example:
- If the results of the **ping ethernet cfm** command show a problem with connectivity to the peer MEP, use the **traceroute ethernet cfm** command to help further isolate the location of the problem as shown in the following example:

DETAILED STEPS

Step 1 To verify connectivity to a problematic MEP, use the **ping ethernet cfm** command as shown in this example:

```
RP/0/RP0/CPU0:router# ping ethernet cfm domain D1 service S1 mep-id 16 source
interface TenGigE 0/0/0/1
```

```
Type escape sequence to abort.
Sending 5 CFM Loopbacks, timeout is 2 seconds -
Domain foo (level 2), Service foo
Source: MEP ID 1, interface TenGigE0/0/0/1
Target: 0001.0002.0003 (MEP ID 16):
Running (5s) ...
Success rate is 60.0 percent (3/5), round-trip min/avg/max = 1251/1349/1402 ms
Out-of-sequence: 0.0 percent (0/3)
```

```
Bad data: 0.0 percent (0/3)
Received packet rate: 1.4 pps
```

Step 2 If the results of the **ping ethernet cfm** command show a problem with connectivity to the peer MEP, use the **traceroute ethernet cfm** command to help further isolate the location of the problem as shown in the following example:

```
RP/0/RP0/CPU0:router# traceroute ethernet cfm domain D1 service S1 mep-id 16 source
interface TenGigE 0/0/0/2
```

```
Traceroutes in domain D1 (level 4), service S1
Source: MEP-ID 1, interface TenGigE0/0/0/2
```

```
=====
Traceroute at 2009-05-18 12:09:10 to 0001.0203.0402,
TTL 64, Trans ID 2:
```

Hop	Hostname/Last	Ingress MAC/name	Egress MAC/Name	Relay
1	ios 0000-0001.0203.0400	0001.0203.0400 [Down] TenGigE0/0/0/2		FDB
2	abc ios		0001.0203.0401 [Ok] Not present	FDB
3	bcd abc	0001.0203.0402 [Ok] TenGigE0/0		Hit

```
Replies dropped: 0
```

If the target was a MEP, verify that the last hop shows “Hit” in the Relay field to confirm connectivity to the peer MEP.

If the Relay field contains “MPDB” for any of the hops, then the target MAC address was not found in the bridge MAC learning table at that hop, and the result is relying on CCM learning. This result can occur under normal conditions, but it can also indicate a problem. If you used the **ping ethernet cfm** command before using the **traceroute ethernet cfm** command, then the MAC address should have been learned. If “MPDB” is appearing in that case, then this indicates a problem at that point in the network.

Configuration Examples for Ethernet OAM

This section provides the following configuration examples:

Configuration Examples for Ethernet CFM

This section includes the following examples:

Ethernet CFM Domain Configuration: Example

This example shows how to configure a basic domain for Ethernet CFM:

```
configure
ethernet cfm
  traceroute cache hold-time 1 size 3000
  domain Domain_One level 1 id string D1
commit
```

Ethernet CFM Service Configuration: Example

This example shows how to create a service for an Ethernet CFM domain:

```
service Bridge_Service bridge group BD1 bridge-domain B1
service Cross_Connect_1 xconnect group XG1 p2p X1
commit
```

Flexible Tagging for an Ethernet CFM Service Configuration: Example

This example shows how to set the number of tags in CFM packets from down MEPs in a CFM domain service:

```
configure
 ethernet cfm
  domain D1 level 1
  service S2 bridge group BG1 bridge-domain BD2
  tags 1
  commit
```

Continuity Check for an Ethernet CFM Service Configuration: Example

This example shows how to configure continuity-check options for an Ethernet CFM service:

```
continuity-check archive hold-time 100
continuity-check loss auto-traceroute
continuity-check interval 100ms loss-threshold 10
commit
```

MIP Creation for an Ethernet CFM Service Configuration: Example

This example shows how to enable MIP auto-creation for an Ethernet CFM service:

```
RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# mip auto-create all
RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# commit
```

Cross-check for an Ethernet CFM Service Configuration: Example

This example shows how to configure cross-check for MEPs in an Ethernet CFM service:

```
mep crosscheck
mep-id 10
mep-id 20
commit
```

Other Ethernet CFM Service Parameter Configuration: Example

This example shows how to configure other Ethernet CFM service options:

```
maximum-meps 4000
log continuity-check errors
commit
exit
exit
exit
```

MEP Configuration: Example

This example shows how to configure a MEP for Ethernet CFM on an interface:

```
interface TenGigE 0/0/0/1
  ethernet cfm
  mep domain Dml service Sv1 mep-id 1
  commit
```

Ethernet CFM Show Command: Examples

These examples show how to verify the configuration of Ethernet Connectivity Fault Management (CFM):

Example 1

This example shows how to display all the maintenance points that have been created on an interface:

```
RP/0/RP0/CPU0:router# show ethernet cfm local maintenance-points
```

Domain/Level	Service	Interface	Type	ID	MAC
fig/5	bay	Gi0/10/0/12	Dn MEP	2	44:55:66
fig/5	bay	Gi0/0/1/0	MIP		55:66:77
fred/3	barney	Gi0/1/0/0	Dn MEP	5	66:77:88!

Example 2

This example shows how to display all the CFM configuration errors on all domains:

```
RP/0/RP0/CPU0:router# show ethernet cfm configuration-errors
```

```
Domain fig (level 5), Service bay
* MIP creation configured using bridge-domain blort, but bridge-domain blort does not exist.

* An Up MEP is configured for this domain on interface TenGigE0/0/0/3 and an Up MEP is
also configured for domain blort, which is at the same level (5).
* A MEP is configured on interface TenGigE0/0/0/1 for this domain/service, which has CC
interval 100ms, but the lowest interval supported on that interface is 1s
```

Example 3

This example shows how to display operational state for local maintenance end points (MEPs):

```
RP/0/RP0/CPU0:router# show ethernet cfm local meps
```

```
A - AIS received           I - Wrong interval
R - Remote Defect received V - Wrong Level
L - Loop (our MAC received) T - Timed out (archived)
C - Config (our ID received) M - Missing (cross-check)
X - Cross-connect (wrong MAID) U - Unexpected (cross-check)
P - Peer port down
```

```
Domain foo (level 6), Service bar
  ID Interface (State)      Dir MEPs/Err RD Defects AIS
-----
  100 Gi1/1/0/1 (Up)       Up    0/0  N  A      L7
```

```
Domain fred (level 5), Service barney
```

```

      ID Interface (State)          Dir MEPS/Err RD Defects AIS
-----
      2 Gi0/1/0/0 (Up)             Up    3/2   Y  RPC    L6
Domain foo (level 6), Service bar
      ID Interface (State)          Dir MEPS/Err RD Defects AIS
-----
      100 Gi1/1/0/1 (Up)           Up     0/0   N  A
Domain fred (level 5), Service barney
      ID Interface (State)          Dir MEPS/Err RD Defects AIS
-----
      2 Gi0/1/0/0 (Up)             Up    3/2   Y  RPC

```

Example 4

This example shows how to display operational state of other maintenance end points (MEPs) detected by a local MEP:

```
RP/0/RP0/CPU0:router# show ethernet cfm peer meps
```

Flags:

```

> - Ok                               I - Wrong interval
R - Remote Defect received           V - Wrong level
L - Loop (our MAC received)         T - Timed out
C - Config (our ID received)        M - Missing (cross-check)
X - Cross-connect (wrong MAID)      U - Unexpected (cross-check)

```

```
Domain fred (level 7), Service barney
Down MEP on TenGigE0/0/0/1, MEP-ID 2
```

```

=====
St   ID MAC address      Port    Up/Downtime    CcmRcvd SeqErr    RDI Error
-----
>   1 0011.2233.4455 Up      00:00:01      1234     0     0     0
R>  4 4455.6677.8899 Up      1d 03:04      3456     0    234    0
L   2 1122.3344.5566 Up      3w 1d 6h      3254     0     0    3254
C   2 7788.9900.1122 Test   00:13         2345     6     20    2345
X   3 2233.4455.6677 Up      00:23         30       0     0     30
I   3 3344.5566.7788 Down   00:34         12345    0    300    1234
V   3 8899.0011.2233 Blocked 00:35         45       0     0     45
T   5 5566.7788.9900          00:56         20       0     0     0
M   6                          0           0       0     0     0
U>  7 6677.8899.0011 Up      00:02         456     0     0     0

```

```
Domain fred (level 7), Service fig
Down MEP on TenGigE0/0/0/12, MEP-ID 3
```

```

=====
St   ID MAC address      Port    Up/Downtime    CcmRcvd SeqErr    RDI Error
-----
>   1 9900.1122.3344 Up      03:45         4321     0     0     0

```

Example 5

This example shows how to display operational state of other maintenance end points (MEPs) detected by a local MEP with details:

```
RP/0/RP0/CPU0:router# show ethernet cfm peer meps detail
```

```
Domain dom3 (level 5), Service ser3
Down MEP on TenGigE0/0/0/1 MEP-ID 1
```

```

=====
Peer MEP-ID 10, MAC 0001.0203.0403
CFM state: Wrong level, for 00:01:34

```

```

Port state: Up
CCM defects detected:    V - Wrong Level
CCMs received: 5
  Out-of-sequence:      0
  Remote Defect received: 5
  Wrong Level:          0
  Cross-connect (wrong MAID): 0
  Wrong Interval:       5
  Loop (our MAC received): 0
  Config (our ID received): 0
Last CCM received 00:00:06 ago:
  Level: 4, Version: 0, Interval: 1min
  Sequence number: 5, MEP-ID: 10
  MAID: String: dom3, String: ser3
  Port status: Up, Interface status: Up

Domain dom4 (level 2), Service ser4
Down MEP on TenGigE0/0/0/2 MEP-ID 1
=====
Peer MEP-ID 20, MAC 0001.0203.0402
  CFM state: Ok, for 00:00:04
  Port state: Up
  CCMs received: 7
    Out-of-sequence:      1
    Remote Defect received: 0
    Wrong Level:          0
    Cross-connect (wrong MAID): 0
    Wrong Interval:       0
    Loop (our MAC received): 0
  Config (our ID received): 0
Last CCM received 00:00:04 ago:
  Level: 2, Version: 0, Interval: 10s
  Sequence number: 1, MEP-ID: 20
  MAID: String: dom4, String: ser4
  Chassis ID: Local: ios; Management address: 'Not specified'
  Port status: Up, Interface status: Up

Peer MEP-ID 21, MAC 0001.0203.0403
  CFM state: Ok, for 00:00:05
  Port state: Up
  CCMs received: 6
    Out-of-sequence:      0
    Remote Defect received: 0
    Wrong Level:          0
    Cross-connect (wrong MAID): 0
    Wrong Interval:       0
    Loop (our MAC received): 0
    Config (our ID received): 0
Last CCM received 00:00:05 ago:
  Level: 2, Version: 0, Interval: 10s
  Sequence number: 1, MEP-ID: 21
  MAID: String: dom4, String: ser4
  Port status: Up, Interface status: Up

Peer MEP-ID 601, MAC 0001.0203.0402
  CFM state: Timed Out (Standby), for 00:15:14, RDI received
  Port state: Down
  CCM defects detected:  Defects below ignored on local standby MEP
                        I - Wrong Interval
                        R - Remote Defect received
                        T - Timed Out
                        P - Peer port down

```

```

CCMs received: 2
  Out-of-sequence:          0
  Remote Defect received:   2
  Wrong Level:              0

  Wrong Interval:          2
  Loop (our MAC received):  0
  Config (our ID received): 0
Last CCM received 00:15:49 ago:
  Level: 2, Version: 0, Interval: 10s
  Sequence number: 1, MEP-ID: 600
  MAID: DNS-like: dom5, String: ser5
  Chassis ID: Local: ios; Management address: 'Not specified'
  Port status: Up, Interface status: Down

```

AIS for CFM Configuration: Examples

Example 1

This example shows how to configure Alarm Indication Signal (AIS) transmission for a CFM domain service:

```

RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)# ethernet cfm
RP/0/RP0/CPU0:router(config-cfm)# domain D1 level 1
RP/0/RP0/CPU0:router(config-cfm-dmn)# service S1 bridge group BG1 bridge-domain BD2
RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# ais transmission interval 1m cos 7

RP/0/RP0/CPU0:routerconfigure
RP/0/RP0/CPU0:router(config)# ethernet cfm
RP/0/RP0/CPU0:router(config-cfm)# domain D1 level 1
RP/0/RP0/CPU0:router(config-cfm-dmn)# service Cross_Connect_1 xconnect group XG1 p2p
RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# ais transmission interval 1m cos 7

```

Example 2

This example shows how to configure AIS logging for a Connectivity Fault Management (CFM) domain service to indicate when AIS or LCK packets are received:

```

RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)# ethernet cfm
RP/0/RP0/CPU0:router(config-cfm)# domain D1 level 1
RP/0/RP0/CPU0:router(config-cfm-dmn)# service S2 bridge group BG1 bridge-domain BD2
RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# log ais

RP/0/RP0/CPU0:routerconfigure
RP/0/RP0/CPU0:router(config)# ethernet cfm
RP/0/RP0/CPU0:router(config-cfm)# domain D1 level 1
RP/0/RP0/CPU0:router(config-cfm-dmn)# service Cross_Connect_1 xconnect group XG1 p2p
RP/0/RP0/CPU0:router(config-cfm-dmn-svc)# log ais

```

This example shows how to configure AIS transmission on a CFM interface.

```

RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)# interface TenGigE 0/1/0/2
RP/0/RP0/CPU0:router(config-if)# ethernet cfm
RP/0/RP0/CPU0:router(config-if-cfm)# ais transmission up interval 1m cos 7

```


AIS for CFM Show Commands: Examples

This section includes the following examples:

show ethernet cfm interfaces ais Command: Example

This example shows how to display the information published in the Interface AIS table:

```
RP/0/RP0/CPU0:router# show ethernet cfm interfaces ais

Defects (from at least one peer MEP):
A - AIS received           I - Wrong interval
R - Remote Defect received V - Wrong Level
L - Loop (our MAC received) T - Timed out (archived)
C - Config (our ID received) M - Missing (cross-check)
X - Cross-connect (wrong MAID) U - Unexpected (cross-check)
P - Peer port down        D - Local port down
```

Interface (State)	Trigger		Transmission			
	AIS Dir	L Defects	Via Levels	L Int	Last started	Packets
TenGigE0/0/0/0 (Up)	Dn	5 RPC	6	7 1s	01:32:56 ago	5576
TenGigE0/0/0/0 (Up)	Up	0 M	2,3	5 1s	00:16:23 ago	983
TenGigE0/0/0/1 (Dn)	Up	D		7 60s	01:02:44 ago	3764
TenGigE0/0/0/2 (Up)	Dn	0 RX	1!			

show ethernet cfm local meps Command: Examples

Example 1: Default

This example shows how to display statistics for local maintenance end points (MEPs):

```
RP/0/RP0/CPU0:router# show ethernet cfm local meps

A - AIS received           I - Wrong interval
R - Remote Defect received V - Wrong Level
L - Loop (our MAC received) T - Timed out (archived)
C - Config (our ID received) M - Missing (cross-check)
X - Cross-connect (wrong MAID) U - Unexpected (cross-check)
P - Peer port down
```

```
Domain foo (level 6), Service bar
  ID Interface (State)      Dir MEPS/Err RD Defects AIS
  -----
  100 Gi1/1/0/1 (Up)       Up   0/0  N  A      7

Domain fred (level 5), Service barney
  ID Interface (State)      Dir MEPS/Err RD Defects AIS
  -----
  2 Gi0/1/0/0 (Up)       Up   3/2  Y  RPC    6
```

Example 2: Domain Service

This example shows how to display statistics for MEPs in a domain service:

```
RP/0/RP0/CPU0:router# show ethernet cfm local meps domain foo service bar detail

Domain foo (level 6), Service bar
```

show ethernet cfm local meps detail Command: Example

```

Down MEP on TenGigE0/0/0/1, MEP-ID 100
=====
Interface state: Up      MAC address: 1122.3344.5566
Peer MEPS: 0 up, 0 with errors, 0 timed out (archived)

CCM generation enabled: No
AIS generation enabled: Yes (level: 7, interval: 1s)
Sending AIS:           Yes (started 01:32:56 ago)
Receiving AIS:         Yes (from lower MEP, started 01:32:56 ago)

Domain fred (level 5), Service barney
Down MEP on TenGigE0/0/0/1, MEP-ID 2
=====
Interface state: Up      MAC address: 1122.3344.5566
Peer MEPS: 3 up, 2 with errors, 0 timed out (archived)
Cross-check defects: 0 missing, 0 unexpected

CCM generation enabled: Yes (Remote Defect detected: Yes)
CCM defects detected:   R - Remote Defect received
                       P - Peer port down
                       C - Config (our ID received)
AIS generation enabled: Yes (level: 6, interval: 1s)
Sending AIS:           Yes (to higher MEP, started 01:32:56 ago)
Receiving AIS:         No

```

Example 4: Detail

This example shows how to display detailed statistics for MEPS in a domain service:

```

RP/0/RP0/CPU0:router# show ethernet cfm local meps detail

Domain foo (level 6), Service bar
Down MEP on TenGigE0/0/0/1, MEP-ID 100
=====
Interface state: Up      MAC address: 1122.3344.5566
Peer MEPS: 0 up, 0 with errors, 0 timed out (archived)

CCM generation enabled: No
AIS generation enabled: Yes (level: 7, interval: 1s)
Sending AIS:           Yes (started 01:32:56 ago)
Receiving AIS:         Yes (from lower MEP, started 01:32:56 ago)

Domain fred (level 5), Service barney
Down MEP on TenGigE0/0/0/1, MEP-ID 2
=====
Interface state: Up      MAC address: 1122.3344.5566
Peer MEPS: 3 up, 2 with errors, 0 timed out (archived)
Cross-check defects: 0 missing, 0 unexpected

CCM generation enabled: Yes (Remote Defect detected: Yes)
CCM defects detected:   R - Remote Defect received
                       P - Peer port down
                       C - Config (our ID received)
AIS generation enabled: Yes (level: 6, interval: 1s)
Sending AIS:           Yes (to higher MEP, started 01:32:56 ago)
Receiving AIS:         No

```

show ethernet cfm local meps detail Command: Example

Use the **show ethernet cfm local meps detail** command to display MEP-related EFD status information. This example shows that EFD is triggered for MEP-ID 100:

```
RP/0/RP0/CPU0:router# show ethernet cfm local meps detail
```

```
Domain foo (level 6), Service bar  
Down MEP on TenGigE0/0/0/1, MEP-ID 100
```

```
=====
```

```
Interface state: Up      MAC address: 1122.3344.5566  
Peer MEPS: 0 up, 0 with errors, 0 timed out (archived)  
Cross-check errors: 2 missing, 0 unexpected
```

```
CCM generation enabled: No  
AIS generation enabled: Yes (level: 7, interval: 1s)  
Sending AIS:           Yes (started 01:32:56 ago)  
Receiving AIS:         Yes (from lower MEP, started 01:32:56 ago)  
EFD triggered:        Yes
```

```
Domain fred (level 5), Service barney  
Down MEP on TenGigE0/0/0/1, MEP-ID 2
```

```
=====
```

```
Interface state: Up      MAC address: 1122.3344.5566  
Peer MEPS: 3 up, 0 with errors, 0 timed out (archived)  
Cross-check errors: 0 missing, 0 unexpected
```

```
CCM generation enabled: Yes (Remote Defect detected: No)  
AIS generation enabled: Yes (level: 6, interval: 1s)  
Sending AIS:           No  
Receiving AIS:         No  
EFD triggered:        No
```



Note You can also verify that EFD has been triggered on an interface using the **show interfaces** and **show interfaces brief** commands. When an EFD trigger has occurred, these commands will show the interface status as *up* and the line protocol state as *down*.

■ **show ethernet cfm local meps detail Command: Example**



CHAPTER 6

Configuring Link Bundling

The Link Bundling feature allows you to group multiple point-to-point links together into one logical link and provide higher bidirectional bandwidth, redundancy, and load balancing between two routers. A virtual interface is assigned to the bundled link. The component links can be dynamically added and deleted from the virtual interface.

The virtual interface is treated as a single interface on which one can configure an IP address and other software features used by the link bundle. Packets sent to the link bundle are forwarded to one of the links in the bundle.

A link bundle is simply a group of ports that are bundled together and act as a single link. The advantages of link bundles are as follows:

- Multiple links can span several line cards to form a single interface. Thus, the failure of a single link does not cause a loss of connectivity.
- Bundled interfaces increase bandwidth availability, because traffic is forwarded over all available members of the bundle. Therefore, traffic can flow on the available links if one of the links within a bundle fails. Bandwidth can be added without interrupting packet flow.

All the individual links within a single bundle must be of the same type and the same speed.

Cisco IOS XR software supports the following method of forming bundles of Ethernet interfaces:

- IEEE 802.3ad—Standard technology that employs a Link Aggregation Control Protocol (LACP) to ensure that all the member links in a bundle are compatible. Links that are incompatible or have failed are automatically removed from a bundle.
- [Limitations and Compatible Characteristics of Ethernet Link Bundles, on page 76](#)
- [Configuring Ethernet Link Bundles, on page 76](#)
- [Configuring LACP Fallback, on page 81](#)
- [VLANs on an Ethernet Link Bundle, on page 82](#)
- [Configuring VLAN over Bundles, on page 83](#)
- [Configuring Multichassis Link Aggregation Control Protocol Session, on page 87](#)
- [Configuring Multichassis Link Aggregation Control Protocol Bundle, on page 89](#)
- [Configuring One-way Pseudowire Redundancy in MC-LAG, on page 91](#)
- [Configuring VPWS Cross-Connects in MC-LAG, on page 92](#)
- [Configuring ICCP based Service Homing, on page 95](#)
- [Configuring VPLS in MC-LAG, on page 97](#)
- [Configuring Multichassis Link Aggregation: Example, on page 99](#)
- [Information About Configuring Link Bundling, on page 104](#)

Limitations and Compatible Characteristics of Ethernet Link Bundles

This list describes the properties and limitations of ethernet link bundles:

- Any type of Ethernet interfaces can be bundled, with or without the use of LACP (Link Aggregation Control Protocol).
- A single router can support a maximum of 63 bundle interfaces. Link bundles of only physical interfaces are supported.
- Physical layer and link layer configuration are performed on individual member links of a bundle.
- Configuration of network layer protocols and higher layer applications is performed on the bundle itself.
- IPv4 and IPv6 addressing is supported on ethernet link bundles.
- A bundle can be administratively enabled or disabled.
- Each individual link within a bundle can be administratively enabled or disabled.
- Ethernet link bundles are created in the same way as Ethernet channels, where the user enters the same configuration on both end systems.
- The MAC address that is set on the bundle becomes the MAC address of the links within that bundle.
- Load balancing (the distribution of data between member links) is done by flow instead of by packet. Data is distributed to a link in proportion to the bandwidth of the link in relation to its bundle.
- QoS is supported and is applied proportionally on each bundle member.
- All links within a single bundle must terminate on the same two systems.
- Bundled interfaces are point-to-point.
- A link must be in the up state before it can be in distributing state in a bundle.
- Only physical links can be bundle members.
- Multicast traffic is load balanced over the members of a bundle. For a given flow, internal processes select the member link and all traffic for that flow is sent over that member.

Configuring Ethernet Link Bundles

This section describes how to configure an Ethernet link bundle.

**Note**

In order for an Ethernet bundle to be active, you must perform the same configuration on both connection endpoints of the bundle.

SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether** *bundle-id*
3. **ipv4 address** *ipv4-address mask*
4. **bundle minimum-active bandwidth** *kbps*
5. **bundle minimum-active links** *links*
6. **bundle maximum-active links** *links* [**hot-standby**]
7. **exit**
8. **interface HundredGigE** *interface-path-id*
9. **bundle id** *bundle-id* [**mode** {**active** | **on** | **passive**}]
10. **bundle port-priority** *priority*
11. **no shutdown**
12. **exit**
13. **bundle id** *bundle-id* [**mode** {**active** | **passive** | **on**}] **no shutdown exit**
14. **end** or **commit**
15. **exit**
16. **exit**
17. Perform Step 1 through Step 15 on the remote end of the connection.
18. **show bundle Bundle-Ether** *bundle-id*
19. **show lacp Bundle-Ether** *bundle-id*

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **interface Bundle-Ether** *bundle-id*

Example:

```
RP/0/RP0/CPU0:router(config)# interface Bundle-Ether 3
```

Creates a new Ethernet link bundle with the specified bundle-id. The range is 1 to 65535.

This **interface Bundle-Ether** command enters you into the interface configuration submenu, where you can enter interface specific configuration commands are entered. Use the **exit** command to exit from the interface configuration submenu back to the normal global configuration mode.

Step 3 **ipv4 address** *ipv4-address mask*

Example:

```
RP/0/RP0/CPU0:router(config-if)# ipv4 address 10.1.2.3 255.0.0.0
```

Assigns an IP address and subnet mask to the virtual interface using the **ipv4 address** configuration subcommand.

Note • Only a Layer 3 bundle interface requires an IP address.

Step 4 **bundle minimum-active bandwidth** *kbps*

Example:

```
RP/0/RP0/CPU0:router(config-if)# bundle minimum-active bandwidth 580000
```

(Optional) Sets the minimum amount of bandwidth required before a user can bring up a bundle.

Step 5 **bundle minimum-active links** *links*

Example:

```
RP/0/RP0/CPU0:router(config-if)# bundle minimum-active links 2
```

(Optional) Sets the number of active links required before you can bring up a specific bundle.

Step 6 **bundle maximum-active links** *links* [**hot-standby**]

Example:

```
RP/0/RP0/CPU0:router(config-if)# bundle maximum-active links 1 hot-standby
```

(Optional) Implements 1:1 link protection for the bundle, which causes the highest-priority link in the bundle to become active and the second-highest-priority link to become the standby. Also, specifies that a switchover between active and standby LACP-enabled links is implemented per a proprietary optimization.

Note • The priority of the active and standby links is based on the value of the **bundle port-priority** command.

Step 7 **exit**

Example:

```
RP/0/RP0/CPU0:router(config-if)# exit
```

Exits interface configuration submode for the Ethernet link bundle.

Step 8 **interface HundredGigE** *interface-path-id*

Example:

```
RP/0/RP0/CPU0:router(config)# interface HundredGigE 0/1/0/1
```

Enters interface configuration mode for the specified interface.

Enter the **HundredGigE** keyword to specify the interface type. Replace the *interface-path-id* argument with the node-id in the *rack/slot/module* format.

Step 9 **bundle id** *bundle-id* [**mode** {**active** | **on** | **passive**}]

Example:

```
RP/0/RP0/CPU0:router(config-if)# bundle-id 3
```

Adds the link to the specified bundle.

To enable active or passive LACP on the bundle, include the optional **mode active** or **mode passive** keywords in the command string.

To add the link to the bundle without LACP support, include the optional **mode on** keywords with the command string.

Note • If you do not specify the **mode** keyword, the default mode is **on** (LACP is not run over the port).

Step 10 **bundle port-priority** *priority*

Example:

```
RP/0/RP0/CPU0:router(config-if)# bundle port-priority 1
```

(Optional) If you set the **bundle maximum-active links** command to 1, you must also set the priority of the active link to the highest priority (lowest value) and the standby link to the second-highest priority (next lowest value). For example, you can set the priority of the active link to 1 and the standby link to 2.

Step 11 **no shutdown**

Example:

```
RP/0/RP0/CPU0:router(config-if)# no shutdown
```

(Optional) If a link is in the down state, bring it up. The **no shutdown** command returns the link to an up or down state depending on the configuration and state of the link.

Step 12 **exit**

Example:

```
RP/0/RP0/CPU0:router(config-if)# exit
```

Exits interface configuration submenu for the Ethernet interface.

Step 13 **bundle id** *bundle-id* [**mode** {**active** | **passive** | **on**}] **no shutdown exit**

Example:

```
RP/0/RP0/CPU0:router(config)# interface TenGigE 0/1/0/1
```

```
RP/0/RP0/CPU0:router(config-if)# bundle id 3
```

```
RP/0/RP0/CPU0:router(config-if)# bundle port-priority 2
```

```
RP/0/RP0/CPU0:router(config-if)# no shutdown
```

```
RP/0/RP0/CPU0:router(config-if)# exit
```

```
RP/0/RP0/CPU0:router(config)# interface TenGigE 0/1/0/1
```

```
RP/0/RP0/CPU0:router(config-if)# bundle id 3
```

```
RP/0/RP0/CPU0:router(config-if)# no shutdown
```

```
RP/0/RP0/CPU0:router(config-if)# exit
```

(Optional) Repeat Step 8 through Step 11 to add more links to the bundle.

Step 14 **end** or **commit**

Example:

```
RP/0/RP0/CPU0:router(config-if)# end
```

or

```
RP/0/RP0/CPU0:router(config-if)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Step 15 **exit**

Example:

```
RP/0/RP0/CPU0:router(config-if)# exit
```

Exits interface configuration mode.

Step 16 **exit**

Example:

```
RP/0/RP0/CPU0:router(config)# exit
```

Exits global configuration mode.

Step 17 Perform Step 1 through Step 15 on the remote end of the connection.

Brings up the other end of the link bundle.

Step 18 **show bundle Bundle-Ether *bundle-id***

Example:

```
RP/0/RP0/CPU0:router# show bundle Bundle-Ether 3
```

(Optional) Shows information about the specified Ethernet link bundle.

Step 19 **show lacp Bundle-Ether *bundle-id***

Example:

```
RP/0/RP0/CPU0:router# show lacp Bundle-Ether 3
```

(Optional) Shows detailed information about LACP ports and their peers.

Configuring LACP Fallback

This section describes how to configure the LACP Fallback feature.

SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether** *bundle-id*
3. **ipv4 address** *ipv4-address mask*
4. **end** or **commit**
5. **show bundle infrastructure database ma bdl-info Bundle-e1010 | inctext**
6. **show bundle infrastructure database ma bdl-info Bundle-e1015 | inctext**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **interface Bundle-Ether** *bundle-id*

Example:

```
RP/0/RP0/CPU0:router(config)# interface Bundle-Ether 3
```

Creates and names a new Ethernet link bundle.

This **interface Bundle-Ether** command enters you into the interface configuration submenu, where you can enter interface-specific configuration commands. Use the **exit** command to exit from the interface configuration submenu back to the normal global configuration mode.

Step 3 **ipv4 address** *ipv4-address mask*

Example:

```
RP/0/RP0/CPU0:router(config-if)# bundle lacp-fallback timeout 4
```

Enables the LACP Fallback feature.

Step 4 **end** or **commit**

Example:

```
RP/0/RP0/CPU0:router(config-subif)# commit
```

Saves configuration changes.

Step 5 **show bundle infrastructure database ma bdl-info Bundle-e1010 | inctext**

Example:

```
RP/0/RP0/CPU0:router# show bundle infrastructure database ma bdl-info Bundle-e1010 | inc "fallback"
```

(Optional) Shows the MA information of the bundle manager.

Step 6 `show bundle infrastructure database ma bdl-info Bundle-e1015 | inc text`

Example:

```
RP/0/RP0/CPU0:router# show bundle infrastructure database ma bdl-info Bundle-e1015 | inc "fallback"
```

(Optional) Shows the MA information of the bundle manager.

VLANs on an Ethernet Link Bundle

802.1Q VLAN subinterfaces can be configured on 802.3ad Ethernet link bundles. Keep the following information in mind when adding VLANs on an Ethernet link bundle:

- There is no separate limit defined for Layer 3 sub-interfaces on a bundle. However, an overall system limit of 4000 is applicable for NCS5001 and NCS5002, while a limit of 2000 is applicable for NCS5011.



Note The memory requirement for bundle VLANs is slightly higher than standard physical interfaces.

To create a VLAN subinterface on a bundle, include the VLAN subinterface instance with the **interface Bundle-Ether** command, as follows:

```
interface Bundle-Ether interface-bundle-id.subinterface
```

After you create a VLAN on an Ethernet link bundle, all VLAN subinterface configuration is supported on that link bundle.

VLAN subinterfaces can support multiple Layer 2 frame types and services, such as Ethernet Flow Points (EFPs) and Layer 3 services.

Layer 2 EFPs are configured as follows:

```
interface bundle-ether instance.subinterface l2transport. encapsulation dot1q xxxxx
```

Layer 3 VLAN subinterfaces are configured as follows:

```
interface bundle-ether instance.subinterface, encapsulation dot1q xxxxx
```



Note The difference between the Layer 2 and Layer 3 interfaces is the **l2transport** keyword. Both types of interfaces use **dot1q encapsulation**.

Configuring VLAN over Bundles

This section describes how to configure a VLAN bundle. The creation of a VLAN bundle involves three main tasks:

SUMMARY STEPS

1. Create an Ethernet bundle.
2. Create VLAN subinterfaces and assign them to the Ethernet bundle.
3. Assign Ethernet links to the Ethernet bundle.

DETAILED STEPS

-
- | | |
|---------------|---|
| Step 1 | Create an Ethernet bundle. |
| Step 2 | Create VLAN subinterfaces and assign them to the Ethernet bundle. |
| Step 3 | Assign Ethernet links to the Ethernet bundle. |
-

These tasks are describe in detail in the procedure that follows.



Note In order for a VLAN bundle to be active, you must perform the same configuration on both ends of the bundle connection.

SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether** *bundle-id*
3. **ipv4 address** *ipv4-address mask*
4. **bundle minimum-active bandwidth** *kbps*
5. **bundle minimum-active links** *links*
6. **bundle maximum-active links** *links* [**hot-standby**]
7. **exit**
8. **interface Bundle-Ether** *bundle-id.vlan-id*
9. **encapsulation dot1q***vlan-id*
10. **ipv4 address** *ipv4-address mask*
11. **no shutdown**
12. **exit**
13. Repeat Step 9 through Step 12 to add more VLANs to the bundle you created in Step 2.
14. **end** or **commit**
15. **exit**
16. **exit**
17. **configure**
18. **interface** {**TenGigE** | **FortyGigE** | **HundredGigE**}*interface-path-id*

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **interface Bundle-Ether *bundle-id***

Example:

```
RP/0/RP0/CPU0:router(config)# interface Bundle-Ether 3
```

Creates and names a new Ethernet link bundle.

This **interface Bundle-Ether** command enters you into the interface configuration submode, where you can enter interface-specific configuration commands. Use the **exit** command to exit from the interface configuration submode back to the normal global configuration mode.

Step 3 **ipv4 address *ipv4-address mask***

Example:

```
RP/0/RP0/CPU0:router(config-if)# ipv4 address 10.1.2.3 255.0.0.0
```

Assigns an IP address and subnet mask to the virtual interface using the **ipv4 address** configuration subcommand.

Step 4 **bundle minimum-active bandwidth *kbps***

Example:

```
RP/0/RP0/CPU0:router(config-if)# bundle minimum-active bandwidth 580000
```

(Optional) Sets the minimum amount of bandwidth required before a user can bring up a bundle.

Step 5 **bundle minimum-active links *links***

Example:

```
RP/0/RP0/CPU0:router(config-if)# bundle minimum-active links 2
```

(Optional) Sets the number of active links required before you can bring up a specific bundle.

Step 6 **bundle maximum-active links *links* [hot-standby]**

Example:

```
RP/0/RP0/CPU0:router(config-if)# bundle maximum-active links 1 hot-standby
```

(Optional) Implements 1:1 link protection for the bundle, which causes the highest-priority link in the bundle to become active and the second-highest-priority link to become the standby. Also, specifies that a switchover between active and standby LACP-enabled links is implemented per a proprietary optimization.

Note The priority of the active and standby links is based on the value of the **bundle port-priority** command.

Step 7 **exit**

Example:

```
RP/0/RP0/CPU0:router(config-if)# exit
```

Exits the interface configuration submenu.

Step 8 **interface Bundle-Ether** *bundle-id.vlan-id***Example:**

```
RP/0/RP0/CPU0:router#(config)# interface Bundle-Ether 3.1
```

Creates a new VLAN, and assigns the VLAN to the Ethernet bundle you created in Step 2.

Replace the *bundle-id* argument with the *bundle-id* you created in Step 2.

Replace the *vlan-id* with a subinterface identifier.

Range is from 1 to 4094 inclusive (0 and 4095 are reserved).

Note When you include the *.vlan-id* argument with the **interface Bundle-Ether** *bundle-id* command, you enter subinterface configuration mode.

Step 9 **encapsulation dot1q***vlan-id***Example:**

```
RP/0/RP0/CPU0:router(config-subif)# encapsulation dot1q 100
```

Sets the Layer 2 encapsulation of an interface.

Step 10 **ipv4 address** *ipv4-address mask***Example:**

```
RP/0/RP0/CPU0:router#(config-subif)# ipv4 address 10.1.2.3/24
```

Assigns an IP address and subnet mask to the subinterface.

Step 11 **no shutdown****Example:**

```
RP/0/RP0/CPU0:router#(config-subif)# no shutdown
```

(Optional) If a link is in the down state, bring it up. The **no shutdown** command returns the link to an up or down state depending on the configuration and state of the link.

Step 12 **exit****Example:**

```
RP/0/RP0/CPU0:router(config-subif)# exit
```

Exits subinterface configuration mode for the VLAN subinterface.

Step 13 Repeat Step 9 through Step 12 to add more VLANs to the bundle you created in Step 2.

(Optional) Adds more subinterfaces to the bundle.

Step 14 **end** or **commit**

Example:

```
RP/0/RP0/CPU0:router(config-subif)# end
```

or

```
RP/0/RP0/CPU0:router(config-subif)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before
exiting(yes/no/cancel)?
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.

- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.

- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Step 15 **exit****Example:**

```
RP/0/RP0/CPU0:router(config-subif)# end
```

Exits interface configuration mode.

Step 16 **exit****Example:**

```
RP/0/RP0/CPU0:router(config)# exit
```

Exits global configuration mode.

Step 17 **configure****Example:**

```
RP/0/RP0/CPU0:router # configure
```

Enters global configuration mode.

Step 18 **interface {TenGigE | FortyGigE | HundredGigE} interface-path-id****Example:**

```
RP/0/RP0/CPU0:router(config)# interface TenGigE 1/0/0/0
```

Enters interface configuration mode for the Ethernet interface you want to add to the Bundle.

Enter the **GigabitEthernet** or **TenGigE** keyword to specify the interface type. Replace the *interface-path-id* argument with the node-id in the rack/slot/module format.

Note A VLAN bundle is not active until you add an Ethernet interface on both ends of the link bundle.

Configuring Multichassis Link Aggregation Control Protocol Session

Perform this task to enable a Multichassis Link Aggregation Control Protocol (mLACP) session.

SUMMARY STEPS

1. **configure**
2. **redundancy iccp group** *group-id*
3. **mlacp system mac** *mac-id*
4. **mlacp system priority** *priority*
5. **mlacp node** *node-id*
6. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RSP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **redundancy iccp group** *group-id*

Example:

```
RP/0/RSP0/CPU0:router#(config-redundancy-iccp-group)# redundancy iccp group 100
```

Adds an ICCP redundancy group.

Step 3 **mlacp system mac** *mac-id*

Example:

```
RP/0/RSP0/CPU0:router#(config-redundancy-iccp-group)# mlacp system mac 1.1.1
```

Configures the LACP system ID to be used in this ICCP Group.

Note

- The *mac-id* is a user configured value for the LACP system LAG-ID to be used by the POAs. It is highly recommended that the *mac-ids* have the same value on both POAs. You can have different LAG-IDs for different groups.

Step 4 `mlacp system priority` *priority***Example:**

```
RP/0/RSP0/CPU0:router#(config-redundancy-iccp-group)# mlacp system priority 10
```

Sets the LACP system priority to be used in this ICCP Group.

- Note**
- It is recommended that system priority of the POAs be configured to a lower numerical value (higher priority) than the LACP LAG ID of the DHD. If the DHD has higher system priority then dynamic priority management cannot work and brute force switchover is automatically used.

Step 5 `mlacp node` *node-id***Example:**

```
RP/0/RSP0/CPU0:router#(config-redundancy-iccp-group)# mlacp node 1
```

Sets the LACP system priority to be used in this ICCP Group.

- Note**
- The *node-id* must be unique for each POA.

Step 6 `end` or `commit`**Example:**

```
RP/0/RSP0/CPU0:router(config-if)# end
```

or

```
RP/0/RSP0/CPU0:router(config-if)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring Multichassis Link Aggregation Control Protocol Bundle

Perform this task to configure a Multichassis Link Aggregation Control Protocol (mLACP) bundle.

SUMMARY STEPS

1. **configure**
2. **interface Bundle-Ether** *bundle-id*
3. **mac-address** *mac-id*
4. **bundle wait-while** *milliseconds*
5. **lACP switchover suppress-flaps** *milliseconds*
6. **mlACP iccp-group** *group-id*
7. **mlACP port-priority** *priority*
8. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RSP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **interface Bundle-Ether** *bundle-id*

Example:

```
RP/0/RSP0/CPU0:router#(config)# interface Bundle-Ether 3
```

Creates and names a new Ethernet link bundle.

Step 3 **mac-address** *mac-id*

Example:

```
RP/0/RSP0/CPU0:router#(config-if)# mac-address 1.1.1
```

Sets the MAC address on the interface.

Note • Configuring the same MAC address on both POAs is highly recommended.

Step 4 **bundle wait-while** *milliseconds*

Example:

```
RP/0/RSP0/CPU0:router#(config-if)# bundle wait-while 100
```

Sets the wait-while timeout for members of this bundle.

Step 5 **lacp switchover suppress-flaps** *milliseconds***Example:**

```
RP/0/RSP0/CPU0:router#(config-if)# lacp switchover suppress-flaps 300
```

Sets the time for which to suppress flaps during a LACP switchover.

Note • It is recommended that the value used for the *milliseconds* argument is greater than that for the wait-while timer of the local device (and DHD).

Step 6 **mlacp iccp-group** *group-id***Example:**

```
RP/0/RSP0/CPU0:router#(config-if)# mlacp iccp-group 10
```

Configures the ICCP redundancy group in which this bundle should operate.

Step 7 **mlacp port-priority** *priority***Example:**

```
RP/0/RSP0/CPU0:router#(config-if)# mlacp port-priority 10
```

Sets the starting priority for all member links on this device when running mLACP.

Note • Lower value indicates higher priority. If you are using dynamic priority management the priority of the links change when switchovers occur.

Step 8 **end** or **commit****Example:**

```
RP/0/RSP0/CPU0:router(config-if)# end
```

or

```
RP/0/RSP0/CPU0:router(config-if)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes: `Uncommitted changes found, commit them before exiting (yes/no/cancel)?`
- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring One-way Pseudowire Redundancy in MC-LAG

Perform this task to allow one-way pseudowire redundancy behavior when the redundancy group is configured.

SUMMARY STEPS

1. **configure**
2. **l2vpn**
3. **pw-class** *{class-name}*
4. **encapsulation mpls**
5. **redundancy one-way**
6. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RSP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **l2vpn**

Example:

```
RP/0/RSP0/CPU0:router(config)# l2vpn
```

```
RP/0/RSP0/CPU0:router(config-l2vpn)#
```

Enters L2VPN configuration mode.

Step 3 **pw-class** *{class-name}*

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn)# pw-class class1
```

Configures the pseudowire class template name to use for the pseudowire.

Step 4 **encapsulation mpls**

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn-pwc)# encapsulation mpls
```

Configures the pseudowire encapsulation to MPLS.

Step 5 **redundancy one-way****Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-pwc-mps)# redundancy one-way
```

Configures one-way PW redundancy behavior.

Note • The **redundancy one-way** command is effective only if the redundancy group is configured.

Step 6 **end or commit****Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-mac)# end
```

or

```
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-mac)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring VPWS Cross-Connects in MC-LAG

Perform this task to configure VPWS cross-connects in MC-LAG.

SUMMARY STEPS

1. **configure**
2. **l2vpn**
3. **pw-status**
4. **xconnect group** *group-name*
5. **p2p** *xconnect-name*
6. **interface** *type interface-path-id*

7. **neighbor** *A.B.C.D* **pw-id** *pseudowire-id*
8. **pw-class** {*class-name*}
9. **backup neighbor** *A.B.C.D* **pw-id** *pseudowire-id*
10. **pw-class** {*class-name*}
11. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RSP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **l2vpn**

Example:

```
RP/0/RSP0/CPU0:router(config)# l2vpn
```

Enters L2VPN configuration mode.

Step 3 **pw-status**

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn)# pw-status
```

Enables pseudowire status.

- Note**
- When the attachment circuit changes redundancy state to Active, Active pw-status is sent over the primary and backup pseudowires.
 - When the attachment circuit changes redundancy state to Standby, Standby pw-status is sent over the primary and backup pseudowires.

Step 4 **xconnect group** *group-name*

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn)# xconnect group grp_1
```

Enters the name of the cross-connect group.

Step 5 **p2p** *xconnect-name*

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn-xc)# p2p p1
```

Enters a name for the point-to-point cross-connect.

Step 6 **interface** *type interface-path-id*

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn-xc-p2p)# interface Bundle-Ether 1.1
```

Specifies the interface type ID.

Step 7 neighbor A.B.C.D pw-id pseudowire-id**Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-xc-p2p)# neighbor 10.2.2.2 pw-id 2000
```

Configures the pseudowire segment for the cross-connect.

Optionally, you can disable the control word or set the transport-type to Ethernet or VLAN.

Step 8 pw-class {class-name}**Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-xc-p2p-pw)# pw-class c1
```

Configures the pseudowire class template name to use for the pseudowire.

Step 9 backup neighbor A.B.C.D pw-id pseudowire-id**Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-xc-p2p-pw)# backup neighbor 10.2.2.2 pw-id 2000
```

Adds a backup pseudowire.

Step 10 pw-class {class-name}**Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-xc-p2p-pw-backup)# pw-class c2
```

Configures the pseudowire class template name to use for the backup pseudowire.

Step 11 end or commit**Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-xc-p2p-pw-backup)# end
```

or

```
RP/0/RSP0/CPU0:router(config-l2vpn-xc-p2p-pw-backup)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before
exiting(yes/no/cancel)?
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.

- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring ICCP based Service Homing

Perform this task to configure ICCP-SM.

Before you begin

You must have configured ICCP as shown in the procedure *Configuring Interchassis Communication Protocol*.

SUMMARY STEPS

1. **configure**
2. **l2vpn**
3. **redundancy iccp group** *group-id*
4. **multi-homing node-id** *node-id*
5. **mac-flush** *type*
6. **interface** *type interface-path-id*
7. **primary vlan** *{vlan range}*
8. **secondary vlan** *{vlan range}*
9. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RSP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **l2vpn**

Example:

```
RP/0/RSP0/CPU0:router(config)# l2vpn  
RP/0/RSP0/CPU0:router(config-l2vpn)#
```

Enters L2VPN configuration mode.

Step 3 **redundancy iccp group** *group-id*

Example:

```
RP/0/RSP0/CPU0:router#(config-l2vpn)# redundancy iccp group 100
```

Enables L2VPN redundancy mode and enters redundancy configuration submenu. Adds an ICCP redundancy group.

Step 4 **multi-homing node-id** *node-id***Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-red-grp)# multi-homing node-id 1
```

Enter the pseudo MLACP node ID. Enables the ICCP based multi-homing service. The node-ID is used for ICCP signaling arbitration.

Step 5 **mac-flush** *type***Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-red-grp)# mac-flush stp-tcn
```

Specifies the type of MAC flush, either stp tcn or mvrp (default).

Step 6 **interface** *type interface-path-id***Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-reg-grp)# interface Bundle-Ether 1
```

Specifies the interface type ID. It can be a physical port name or the main bundle name (sub-port is not allowed). It can be any physical Ethernet or bundle Ethernet interface connecting to a dual homed CE device.

Only bundle-ethernet main ports are allowed for ICCP-SM. If you want to use this feature on a single ethernet link, then you must configure a bundle with that link.

Step 7 **primary vlan** *{vlan range}***Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-reg-grp)# primary vlan 1-10
```

Configures the list of VLANs under the main port, which default to active (forwarding) when there are no faults detected.

Specify the list of of comma separated VLAN ranges or individual VLANs.

Step 8 **secondary vlan** *{vlan range}***Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-reg-grp)# secondary vlan 11-20
```

Configures the list of VLANs under the main port, which default to standby (blocked) when there are no faults detected.

Specify the list of of comma separated VLAN ranges or individual VLANs.

Step 9 **end** or **commit****Example:**

```
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-vfi-pw)# end
```

or

```
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-vfi-pw)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes: `Uncommitted changes found, commit them before exiting (yes/no/cancel)?`
- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Note You can use the **show iccp group**, **show l2vpn iccp-sm** and **show lacp bundle-ether** commands to monitor ICCP-SM.

Configuring VPLS in MC-LAG

Perform this task to configure VPLS in MC-LAG.

SUMMARY STEPS

1. **configure**
2. **l2vpn**
3. **pw-status**
4. **bridge group** *bridge-group-name*
5. **bridge-domain** *bridge-domain-name*
6. **interface** *type interface-path-id*
7. **vfi** *{vfi-name}*
8. **neighbor** *A.B.C.D pw-id pseudowire-id*
9. **pw-class** *{class-name}*
10. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RSP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **l2vpn**

Example:

```
RP/0/RSP0/CPU0:router(config)# l2vpn
```

Enters L2VPN configuration mode.

Step 3 **pw-status**

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn)# pw-status
```

(Optional) Enables pseudowire status.

All the pseudowires in the VFI are always active, independent of the attachment circuit redundancy state.

Step 4 **bridge group** *bridge-group-name*

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group cisco
RP/0/RSP0/CPU0:router(config-l2vpn-bg)#
```

Creates a bridge group so that it can contain bridge domains and then assigns network interfaces to the bridge domain.

Step 5 **bridge-domain** *bridge-domain-name*

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain abc
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)#
```

Establishes a bridge domain and enters L2VPN bridge group bridge domain configuration mode.

Step 6 **interface type** *interface-path-id*

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# interface Bundle-Ether 1.1
```

Specifies the interface type ID.

Step 7 **vfi** *{vfi-name}*

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-ac)# vfi vfi-east
```

Enters virtual forwarding instance (VFI) configuration mode.

Step 8 **neighbor** *A.B.C.D* **pw-id** *pseudowire-id*

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-vfi)# neighbor 10.2.2.2 pw-id 2000
```

Configures the pseudowire segment for the cross-connect.

Optionally, you can disable the control word or set the transport-type to Ethernet or VLAN.

Step 9 `pw-class {class-name}`

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-vfi-pw)# pw-class canada
```

Configures the pseudowire class template name to use for the pseudowire.

Step 10 `end` or `commit`

Example:

```
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-vfi-pw)# end
```

or

```
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-vfi-pw)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before
exiting(yes/no/cancel)?
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.

- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.

- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring Multichassis Link Aggregation: Example

This example shows how to configure POAs:

Active PoA

```
l2vpn bridge group bg1
bridge-domain bd1
neighbor 101.101.101.101 pw-id 5000
pw-class class1
backup neighbor 102.102.102.102 pw-id 3000
pw-class class1
!
!
!
```

```
!
```

Standby PoA

```
interface Bundle-Ether10
mlacp iccp-group 1
mlacp port-priority 20
```

This example shows how to configure ICCP:

```
redundancy iccp group
member neighbor 1.2.3.4
backbone interface TenGigE 0/0/0/0
isolation recovery-delay 30
```

This example shows how to configure mLACP:

```
configure
redundancy iccp group 100
mlacp system mac 1.1.1
mlacp system priority 10
mlacp node 1
interface Bundle-Ether 3
mac-address 1.1.1
bundle wait-while 100
lacp switchover suppress-flaps 300
mlacp iccp-group 100
```

This example illustrates a switchover:

```
RP/0/0/CPU0:router# show bundle

Bundle-Ether1
Status: Up
Local links <active/standby/configured>: 1 / 0 / 1
Local bandwidth <effective/available>: 1000000 (1000000) kbps
MAC address (source): 0000.deaf.0000 (Configured)
Minimum active links / bandwidth: 1 / 1 kbps
Maximum active links: 64
Wait while timer: 100 ms
LACP: Operational
Flap suppression timer: 300 ms
mLACP: Operational
ICCP Group: 1
Role: Active
Foreign links <active/configured>: 0 / 1
Switchover type: Non-revertive
Recovery delay: 300 s
Maximize threshold: Not configured
IPv4 BFD: Not configured

Port Device State Port ID B/W, kbps
-----
Te0/0/0/0 Local Active 0x8001, 0x9001 1000000
Link is Active
Te0/0/0/0 5.4.3.2 Standby 0x8002, 0xa001 1000000
Link is marked as Standby by mLACP peer
```

```
RP/0/0/CPU0:router#mlacp switchover Bundle-Ether 1
```

This will trigger the peer device (Node 5.4.3.2 in IG 1) to become active for Bundle-Ether1.
This may result in packet loss on the specified bundle.

```
Proceed with switch over? [confirm]
```

```
RP/0/0/CPU0:Jan 31 23:46:44.666 : BM-DISTRIB[282]: %L2-BM-5-MLACP_BUNDLE_ACTIVE : This
device is no longer the active device for Bundle-Ether1
RP/0/0/CPU0:Jan 31 23:46:44.668 : BM-DISTRIB[282]: %L2-BM-6-ACTIVE : TenGigE0/0/0/0 is no
longer Active as part of Bundle-Ether1
(Not enough links available to meet minimum-active threshold)
```

```
RP/0/0/CPU0:router#show bundle
Mon Jun 7 06:04:17.778 PDT
```

```
Bundle-Ether1
Status: mLACP hot standby
Local links <active/standby/configured>: 0 / 1 / 1
Local bandwidth <effective/available>: 0 (0) kbps
MAC address (source): 0000.deaf.0000 (Configured)
Minimum active links / bandwidth: 1 / 1 kbps
Maximum active links: 64
Wait while timer: 100 ms
LACP: Operational
Flap suppression timer: 300 ms
mLACP: Operational
ICCP Group: 1
Role: Standby
Foreign links <active/configured>: 1 / 1
Switchover type: Non-revertive
Recovery delay: 300 s
Maximize threshold: Not configured
IPv4 BFD: Not configured
```

```
Port Device State Port ID B/W, kbps
```

```
-----
Te0/0/0/0 Local Standby 0x8003, 0x9001 1000000
mLACP peer is active
Te0/0/0/0 5.4.3.2 Active 0x8002, 0xa001 1000000
Link is Active
RP/0/0/CPU0:router#
```

This example shows how to add a backup pseudowire to a VPLS access pseudowire:

```
l2vpn bridge group bg1
bridge-domain bd1
neighbor 101.101.101.101 pw-id 5000
pw-class class1
backup neighbor 102.102.102.102 pw-id 3000
pw-class class1
!
!
!
!
```

This example shows how to configure one-way pseudowire redundancy behavior when redundancy group is configured:

This example illustrates an overall MC-LAG configuration:

Topology:

```
DHD POA 1 POA 2
```

```
Te0/0/0/0 ----- Te0/0/0/0
Te0/0/0/1 ----- Te0/0/0/1
Te0/0/0/2
Te0/0/0/3 ----- Te0/0/0/0
Te0/0/0/4 ----- Te0/0/0/1
Te0/0/0/2 Te0/0/0/2
Te0/0/0/3 ----- Te0/0/0/3
Te0/0/0/4 ----- Te0/0/0/4
```

```
On POA 1:
```

```
redundancy
iccp
group 1
mlacp node 1
mlacp system mac 000d.000e.000f
mlacp system priority 1
member
neighbor 5.4.3.2
!
!
!
!
interface Bundle-Ether1
lacp switchover suppress-flaps 300
mlacp iccp-group 1
mac-address 0.deaf.0
bundle wait-while 100
!
interface Loopback0
ipv4 address 5.4.3.1 255.255.255.255
!
interface TenGigE0/0/0/0
description Connected to DHD Te0/0/0/0
bundle id 1 mode active
lacp period short
no shutdown
!
interface tenGigE0/0/0/3
description Connected to POA2 Te0/0/0/3
ipv4 address 1.2.3.1 255.255.255.0
proxy-arp
no shutdown
!
router static
address-family ipv4 unicast
5.4.3.2/32 1.2.3.2
!
!
mpls ldp
router-id 5.4.3.1
discovery targeted-hello accept
log
neighbor
!
```



```
interface TenGigE0/0/0/3
!
!
On POA 2:

redundancy
iccp
group 1
mlacp node 2
mlacp system mac 000d.000e.000f
mlacp system priority 1
member
neighbor 5.4.3.1
!
!
!
!
interface Bundle-Ether1
lacp switchover suppress-flaps 300
mlacp iccp-group 1
mac-address 0.deaf.0
bundle wait-while 100
!
interface Loopback0
ipv4 address 5.4.3.2 255.255.255.255
!
interface TenGigE0/0/0/0
description Connected to DHD Te0/0/0/3
bundle id 1 mode active
lacp period short
no shutdown
!
interface TenGigE0/0/0/3
description Connected to POA1 Te0/0/0/3
ipv4 address 1.2.3.2 255.255.255.0
proxy-arp
no shutdown
!
router static
address-family ipv4 unicast
5.4.3.1/32 1.2.3.1
!
!
mpls ldp
router-id 5.4.3.2
discovery targeted-hello accept
log
neighbor
!
interface TenGigE0/0/0/3
!
!
On the DHD:

interface Bundle-Ether1
lacp switchover suppress-flaps 300
bundle wait-while 100
!
interface TenGigE0/0/0/0
description Connected to POA1 Te0/0/0/0
bundle id 1 mode active
lacp period short
```

```
no shutdown
!  
interface TenGigE0/0/0/3  
description Connected to POA2 Te0/0/0/0  
bundle id 1 mode active  
lACP period short  
no shutdown  
!
```

Information About Configuring Link Bundling

To configure link bundling, you must understand the following concepts:

IEEE 802.3ad Standard

The IEEE 802.3ad standard typically defines a method of forming Ethernet link bundles.

For each link configured as bundle member, the following information is exchanged between the systems that host each end of the link bundle:

- A globally unique local system identifier
- An identifier (operational key) for the bundle of which the link is a member
- An identifier (port ID) for the link
- The current aggregation status of the link

This information is used to form the link aggregation group identifier (LAG ID). Links that share a common LAG ID can be aggregated. Individual links have unique LAG IDs.

The system identifier distinguishes one router from another, and its uniqueness is guaranteed through the use of a MAC address from the system. The bundle and link identifiers have significance only to the router assigning them, which must guarantee that no two links have the same identifier, and that no two bundles have the same identifier.

The information from the peer system is combined with the information from the local system to determine the compatibility of the links configured to be members of a bundle.

The MAC address of the first link attached to a bundle becomes the MAC address of the bundle itself. The bundle uses this MAC address until that link (the first link attached to the bundle) is detached from the bundle, or until the user configures a different MAC address. The bundle MAC address is used by all member links when passing bundle traffic. Any unicast or multicast addresses set on the bundle are also set on all the member links.



Note

We recommend that you avoid modifying the MAC address, because changes in the MAC address can affect packet forwarding.

Link Bundle Configuration Overview

The following steps provide a general overview of the link bundle configuration. Keep in mind that a link must be cleared of all previous network layer configuration before it can be added to a bundle:

1. In global configuration mode, create a link bundle. To create an Ethernet link bundle, enter the **interface Bundle-Ether** command.
2. Assign an IP address and subnet mask to the virtual interface using the **ipv4 address** command.
3. Add interfaces to the bundle you created in Step 1 with the **bundle id** command in the interface configuration submode.

You can add up to 32 links to a single bundle.

4. You can optionally implement 1:1 link protection for the bundle by setting the **bundle maximum-active links** command to 1. Performing this configuration causes the highest-priority link in the bundle to become active and the second-highest-priority link to become the standby. (The link priority is based on the value of the **bundle port-priority** command.) If the active link fails, the standby link immediately becomes the active link.



Note A link is configured as a member of a bundle from the interface configuration submode for that link.

Link Switchover

By default, a maximum of 64 links in a bundle can actively carry traffic. If one member link in a bundle fails, traffic is redirected to the remaining operational member links.

You can optionally implement 1:1 link protection for a bundle by setting the **bundle maximum-active links** command to 1. By doing so, you designate one active link and one or more dedicated standby links. If the active link fails, a switchover occurs and a standby link immediately becomes active, thereby ensuring uninterrupted traffic.

If the active and standby links are running LACP, you can choose between an IEEE standard-based switchover (the default) or a faster proprietary optimized switchover. If the active and standby links are not running LACP, the proprietary optimized switchover option is used.

Regardless of the type of switchover you are using, you can disable the wait-while timer, which expedites the state negotiations of the standby link and causes a faster switchover from a failed active link to the standby link.

To do so, you can use the **lacp fast-switchover** command.

LACP Fallback

The LACP Fallback feature allows an active LACP interface to establish a Link Aggregation Group (LAG) port-channel before the port-channel receives the Link Aggregation and Control Protocol (LACP) protocol data units (PDU) from its peer. With the LACP Fallback feature configured, the router allows the server to bring up the LAG, before receiving any LACP PDUs from the server, and keeps one port active. This allows the server to establish a connection to PXE server over one Ethernet port, download its boot image and then

continue the booting process. When the server boot process is complete, the server fully forms an LACP port-channel.

Multichassis Link Aggregation

The Multichassis Link Aggregation (MC-LAG) feature provides an end to end interchassis redundancy solution for the Carrier Ethernet Networks. MC-LAG involves two devices collaborating to act as a single LAG from the perspective of a (third) connected device, thus providing device-level as well as link-level redundancy.

To achieve this, two devices co-ordinate with each other to present a single LACP bundle (spanning the two devices) to a partner device. Only one of the devices forwards traffic at any one time, eliminating the risk of forwarding loops. When a failure occurs, these devices coordinate to perform a switchover, changing the device on which traffic is being forwarded by manipulating the link LACP states.

The existing pseudowire redundancy in the core network coordinates with the redundancy in the access network based on:

- Multichassis Link Aggregation Control Protocol (mLACP)
- Interchassis Communication Protocol (ICCP)

The mLACP protocol defines the expected behavior between the two devices and uses the Interchassis Control Protocol (ICCP) to exchange TLVs and identify peer devices to operate with. At the edge of a provider's network, a simple customer edge (CE) device that only supports standard LACP is connected to two provider edge (PE) devices. Thus the CE device is dual-homed, providing better L2 redundancy from the provider's side. In mLACP terminology, the CE device is referred to as a dual-homed device (DHD) and each PE device is known as a point of attachment (POA). The POA forwarding traffic for the bundle is the active device for that bundle, while the other POA is the standby device.

For information on MC-LAG Active/Active, refer to the *L2VPN and Ethernet Services Configuration Guide*.

Failure Cases

MC-LAG provides redundancy, switching traffic to the unaffected POA while presenting an unchanged bundle interface to the DHD, for these failure events:

- Link failure: A port or link between the DHD and one of the POAs fails.
- Device failure: Meltdown or reload of one of the POAs, with total loss of connectivity (to the DHD, the core and the other POA).
- Core isolation: A POA loses its connectivity to the core network, and therefore is of no value, being unable to forward traffic to or from the DHD.

A loss of connectivity between the POAs leads both devices to assume that the other has experienced device failure, causing them to attempt to take on the Active role. This is known as a split brain scenario and can happen in either of the following cases:

- All other connectivity remains; only the link between POAs is lost.
- One POA is isolated from the core network (i.e. a core isolation scenario where the connection between the two POAs was over the core network).

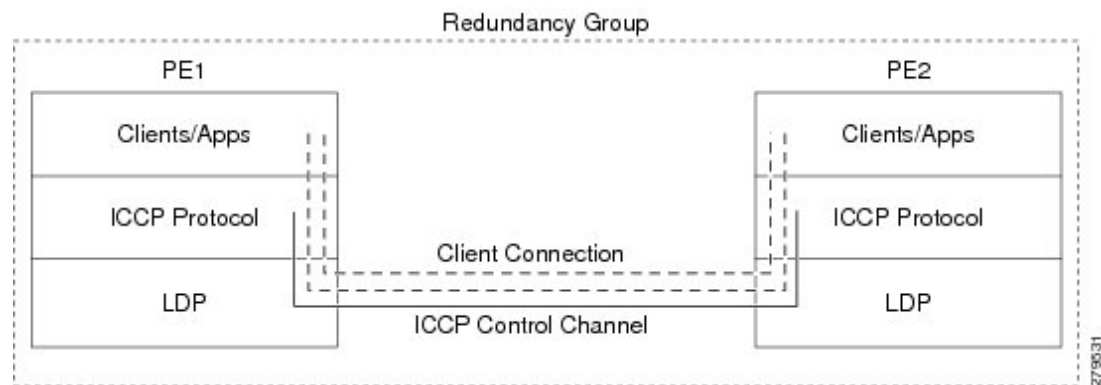
MC-LAG by itself does not provide a means to avoid this situation; resiliency in the connection between the POAs is a requirement. The DHD is given the responsibility of mitigating the problem by setting a limit on

the number of links, within the bundle, that can be active. As such only the links connected to one of the POAs can be active at any one point of time.

Interchassis Communication Protocol

This figure shows the graphical representation of the Interchassis Communication Protocol (ICCP).

Figure 10: ICCP Protocol



Two POAs communicate with each other over an LDP link using the Interchassis Communication Protocol (ICCP). ICCP is an LDP based protocol wherein an LDP session is created between the POAs in a redundancy group, and the ICCP messages are carried over that LDP session. The PE routers in a redundancy group may be a single-hop (directly connected) or a multi-hop away from one another. The ICCP protocol manages the setup and controls the redundancy groups. It also establishes, maintains, and tears down ICCP connections. The ICCP protocol uses route-watch to monitor the connectivity to the PEs in a given redundancy group. It is also responsible for tracking core isolation failures. It notifies all client applications of failure (core isolation and active PE failure).

To operate ICCP, the devices are configured as members of redundancy groups (RGs).



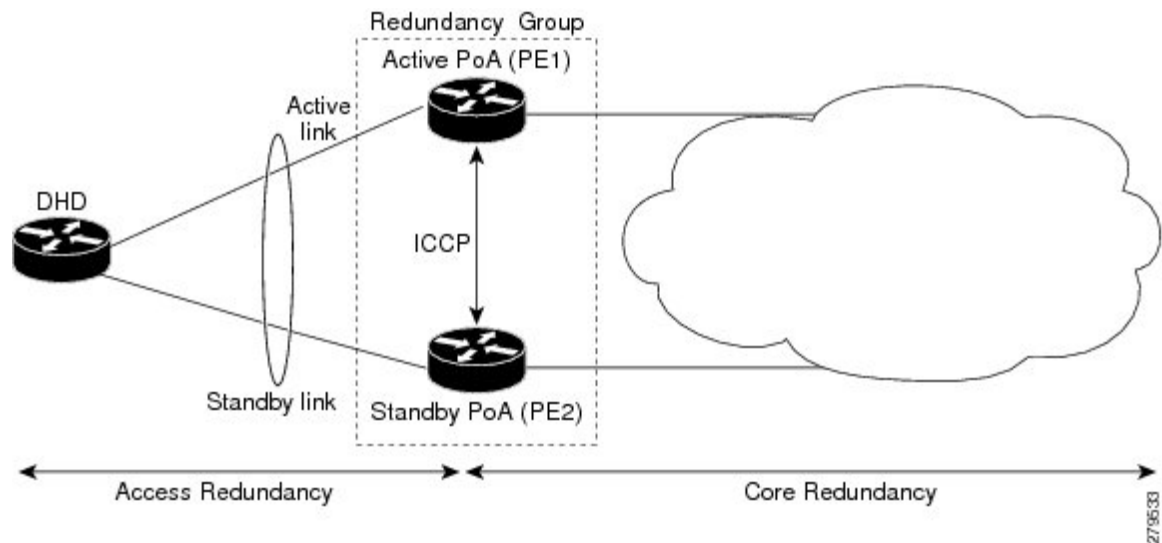
Note In the mLACP configuration, two devices are configured to be members of each RG (until a device-level failure occurs leaving only a single member). However, each device can be a member of more than one RG.

In each redundancy group, a POA's mLACP peer is the other POA in that group, with which it communicates using mLACP over ICCP. For each bundle, the POA and DHD at each end are LACP partners, communicating using the standard LACP protocol.

Access Network Redundancy Model

The Multichassis Link Aggregation Control Protocol (mLACP) based redundancy between the customer edge device (CE) or access network and the provider edge (PE) device is achieved by allowing the CE to be connected to two PE routers. The two PE routers synchronize the data through ICCP; therefore they appear as a single device to the CE.

Figure 11: mLACP/ICCP Redundancy Model



The CE is also called dual-homed device (DHD) and the PE is also called point of attachment (POA). The pair of POAs that is connected to the single DHD forms a redundancy group (RG).

At any given time, only one POA is active for a bundle. Only the set of links between the DHD and the active POA actively sends traffic. The set of links between the DHD and the standby POA does not forward traffic. When the multichassis link bundle software detects that the connection to the active POA has failed, the software triggers the standby POA to become the active POA, and the traffic flows using the links between the DHD and newly active POA.

The ICCP protocol operates between the active and the standby POAs, and allows the POAs to coordinate their configuration, determine which POA is active, and trigger a POA to become active. Applications running on the two POAs (mLACP, IGMP snooping, DHCP snooping or ANCP) synchronize their state using ICCP.

ICCP Based Service Multihoming

In the case of ICCP based Service Multihoming (ICCP-SM), the CE device uses two independent bundle interfaces to connect to the PoAs. Although bundle interfaces are used, they are not aggregated across the two chassis, and mLACP is not involved in the communication. The CE device configures the bundle interfaces in such a manner that all VLANs are allowed on both bundles. You can manually configure the PoAs to distribute the VLANs across the two bundles in order that individual VLANs are active (forwarding) on one bundle or PoA, and standby (blocked) on the other. The CE device initially floods a traffic flow on both bundles and learns the MAC address on the interface where it receives the response.

With ICCP-SM, you are not limited to a dual homed device. The access links can connect to a dual homed network (DHN) that are separate devices in the access network. The two bundles on the DHD or the DHN must be in a bridge domain so that L2 learning selects the link with the active set of VLANs.

Figure 12: ICCP Based Service Multihoming

If a bundle interface between the CE and the PoA fails, ICCP-SM on the PoA with the failed bundle communicates through ICCP to the other PoA's ICCP-SM. This activates the standby VLANs on the remaining bundle. A MAC flush is sent to the CE so that packets destined to hosts on the failed bundle are again flooded, in order to be learned on the newly activated bundle. The MAC flush is required because it is possible that the bundle interface failure is not detected by the CE.

In ICCP Based Service Multihoming, the total set of VLANs are split into a primary set and a secondary set and are configured on each PoA such that the primary set on one PoA is configured as secondary on the other. On each PoA, the VLANs are associated with ACs. If the VLANs are primary on a PoA and there are no faults, the associated ACs are set to forwarding. If the VLANs are secondary on a PoA, the associated ACs are blocked. ICCP-SM is only supported in VPLS cores.

Advantages of Pseudo mLACP:

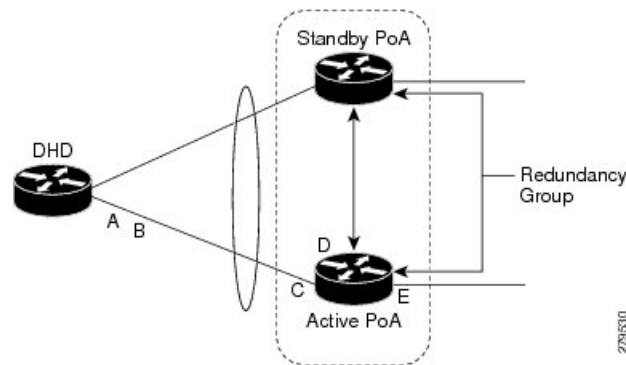
Pseudo mLACP has these three major advantages over mLACP:

- Pseudo mLACP can support a Dual Homed Network (DHN), while mLACP can only support a Dual Homed Device (DHD).
- Pseudo mLACP supports per-VLAN active/active redundancy without any load-balancing requirements on the CE.
- Pseudo mLACP does not require LACP support from the DHD, or DHN. It is independent of the access redundancy mechanism; therefore, it provides a network based redundancy solution. It allows maximum flexibility for the PE-CE interoperability in terms of dual-homing redundancy and recovery.

Failure Modes

The mLACP feature provides network resiliency by protecting against port, link, and node failures. This figure depicts the various failure modes.

Figure 13: Failure Modes



These are the failure categories:

- A—DHD uplink port failure. The port on the DHD that is connected to the POA fails.
- B—DHD uplink failure. The connection between the DHD and the POA fails.
- C—Active POA downlink port failure.
- D—Active POA node failure.
- E—Active POA uplink failure (network isolation). The links between the active POA and the core network fails



Note ICCP Based Service Multihoming is similar to MC-LAG in the case of core network failures. It is revertive in nature. In the case of a failure, the PoA whose link has been restored activates the VLANs that are configured as primary.

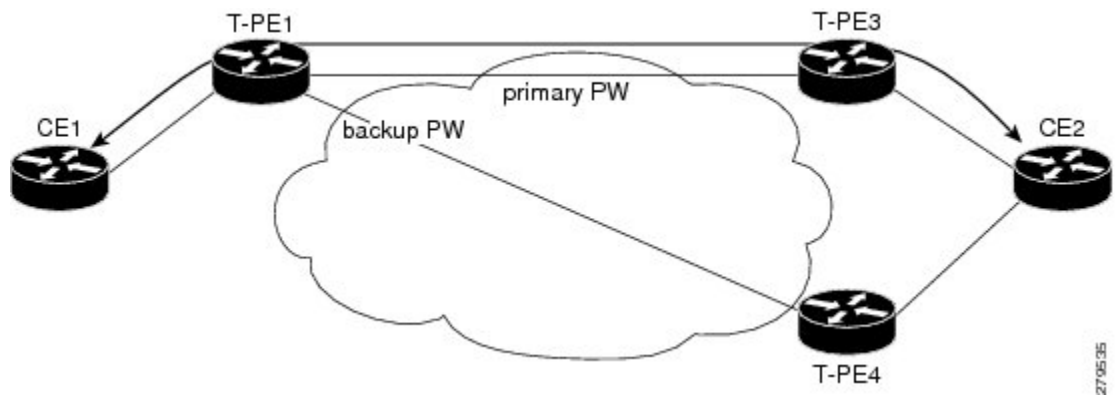
Core Network Redundancy Model

This section explains:

One-way Pseudowire Redundancy

This figure shows the VPWS one-way pseudowire redundancy model. Only one end of the pseudowire is protected by a backup pseudowire.

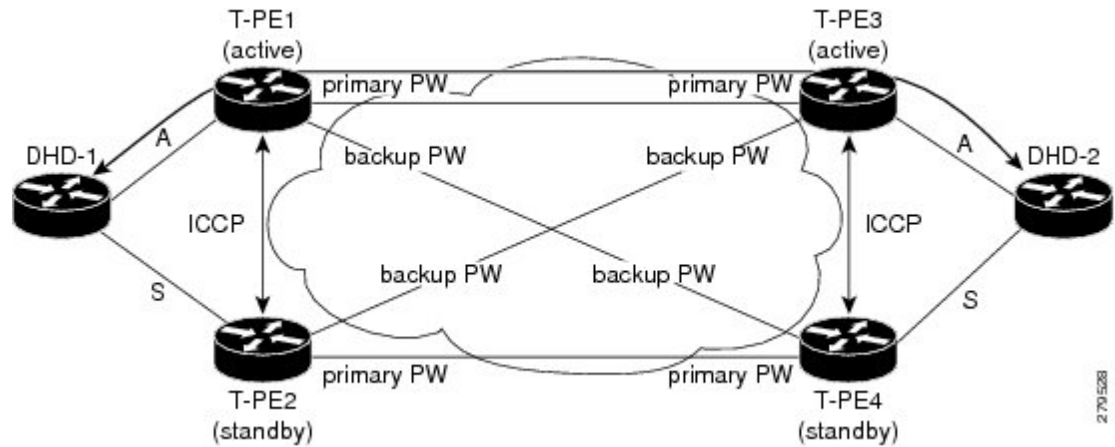
Figure 14: VPWS one-way Pseudowire Redundancy



Two-way Pseudowire Redundancy

This figure shows the VPWS two-way pseudowire redundancy model. In this topology, each T-PE at the end of a PW has a primary and a backup PW. The state of the PW is coordinated with the state of the mLACP link between the DHD and the PE.

Figure 15: VPWS two-way Pseudowire Redundancy



Switchovers

Switchovers, which is changing the Active/Standby roles of the POAs, are performed using dynamic priority management or brute force behavior.

Dynamic Priority Management

Dynamic Priority Management involves co-ordination between the POAs to manipulate the LACP port priorities of their member links. Two priority values are tracked for each links:

- A configured priority which can either be configured explicitly, or defaults to 32768
- An operational priority used in LACP negotiations, which may differ from the configured priority if switchovers have occurred.

Higher priority LACP links are always selected ahead of lower priority LACP links. This means the operational priorities can be manipulated to force the standard LACP Selection Logic (on the POAs and on the DHD) to select desired links on both ends.

For example, consider a case where the DHD has two links to each POA, and each POA is configured with minimum-active links is 2. (This means the bundle goes down on the POA if the number of active links falls below 2.) The operational priorities for the member links are 1 on POA-1 and 2 on POA-2. This means that POA-1 is active (being higher priority) and the links on POA-2 are held in Standby state. The sequence of events in a switchover is as follows:

1. A link fails on POA-1, causing the number of active links to fall below the minimum of 2.
2. POA-1 changes the operational priority of both its links to 3, so the links on POA 2 are now higher priority.
3. POA-1 sends a LACP message to the DHD and an mLACP message to POA-2, informing both devices of the change.
4. The DHD tries to activate the links connected to POA-2 as these now have the highest priority.
5. POA-2 also ensures that its links have the highest priority and activates its links to the DHD.

At this point the switchover is complete.

MC-LAG Topologies

This section illustrates the supported MC-LAG topologies.

Figure 16: VPWS One-way Pseudowire Redundancy in Redundancy Group

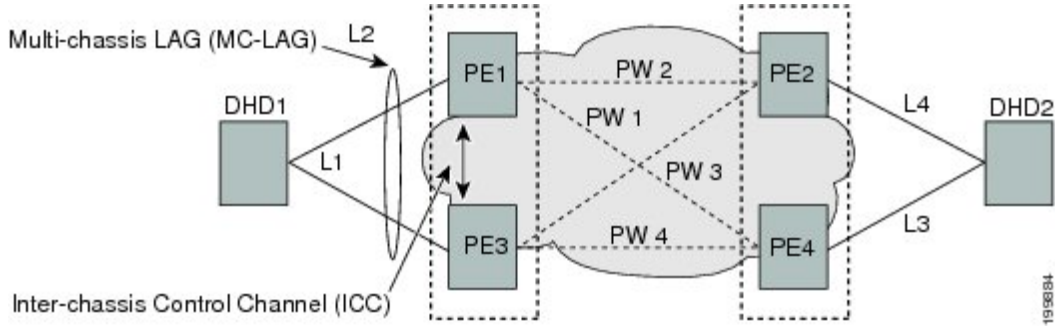


Figure 17: VPWS Two-way Pseudowire Redundancy

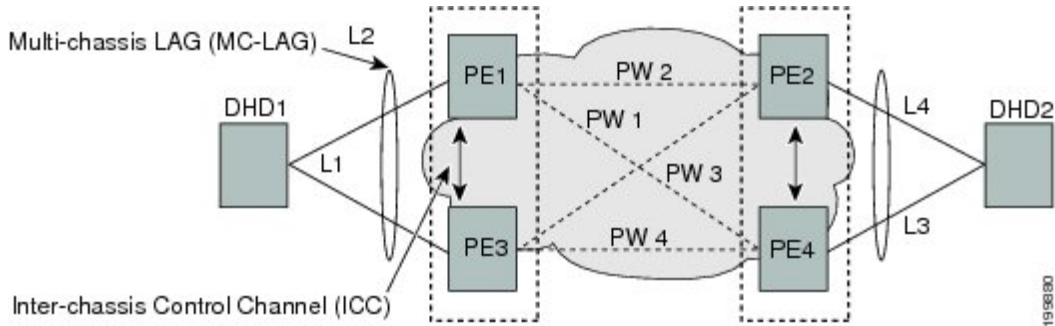


Figure 18: VPLS Pseudowires in One Redundancy Group

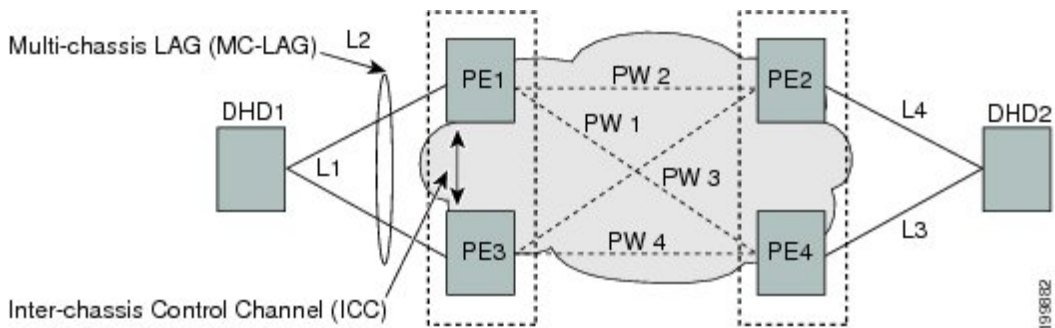
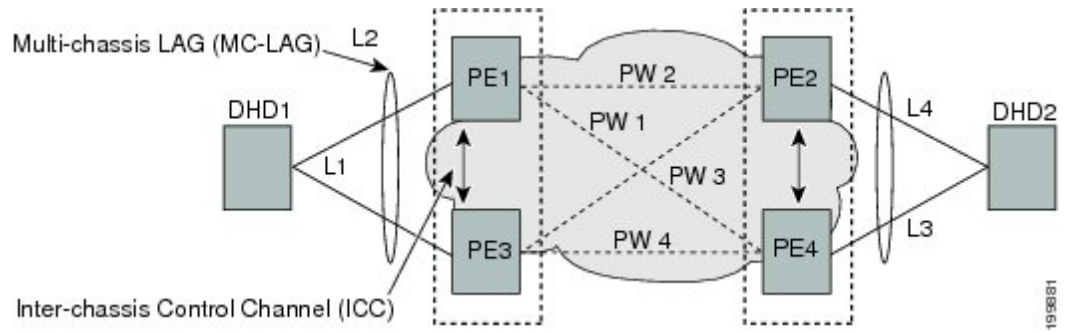


Figure 19: VPLS Pseudowires in Two Redundancy



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CHAPTER 7

Configuring Virtual Loopback and Null Interfaces

This module describes the configuration of loopback and null interfaces. Loopback and null interfaces are considered virtual interfaces.

A virtual interface represents a logical packet switching entity within the router. Virtual interfaces have a global scope and do not have an associated location. Virtual interfaces have instead a globally unique numerical ID after their names. Examples are Loopback 0, Loopback 1, and Loopback 99999. The ID is unique per virtual interface type to make the entire name string unique such that you can have both Loopback 0 and Null 0.

Loopback and null interfaces have their control plane presence on the active route switch processor (RSP). The configuration and control plane are mirrored onto the standby RSP and, in the event of a failover, the virtual interfaces move to the ex-standby, which then becomes the newly active RSP.

- [Information About Configuring Virtual Interfaces, on page 115](#)

Information About Configuring Virtual Interfaces

To configure virtual interfaces, you must understand the following concepts:

Virtual Loopback Interface Overview

A virtual loopback interface is a virtual interface with a single endpoint that is always up. Any packet transmitted over a virtual loopback interface is immediately received by the same interface. Loopback interfaces emulate a physical interface.

In Cisco IOS XR Software, virtual loopback interfaces perform these functions:

- Loopback interfaces can act as a termination address for routing protocol sessions. This allows routing protocol sessions to stay up even if the outbound interface is down.
- You can ping the loopback interface to verify that the router IP stack is working properly.

In applications where other routers or access servers attempt to reach a virtual loopback interface, you must configure a routing protocol to distribute the subnet assigned to the loopback address.

Packets routed to the loopback interface are rerouted back to the router or access server and processed locally. IP packets routed out to the loopback interface but not destined to the loopback interface are dropped. Under these two conditions, the loopback interface can behave like a null interface.

Prerequisites for Configuring Virtual Interfaces

You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

Configuring Virtual Loopback Interfaces

This task explains how to configure a basic loopback interface.

Restrictions

The IP address of a loopback interface must be unique across all routers on the network. It must not be used by another interface on the router, and it must not be used by an interface on any other router on the network.

SUMMARY STEPS

1. **configure**
2. **interface loopback** *instance*
3. **ipv4 address** *ip-address*
4. **end** or **commit**
5. **show interface***type instance*

DETAILED STEPS

Step 1 **configure****Example:**

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **interface loopback** *instance***Example:**

```
RP/0/RP0/CPU0:router#(config)# interface Loopback 3
```

Enters interface configuration mode and names the new loopback interface.

Step 3 **ipv4 address** *ip-address***Example:**

```
RP/0/RP0/CPU0:router(config-if)# ipv4 address 100.100.100.69 255.255.255.255
```

Assigns an IP address and subnet mask to the virtual loopback interface using the **ipv4 address** configuration command.

Step 4 **end** or **commit****Example:**

```
RP/0/RP0/CPU0:router(config-if)# end
```

or

```
RP/0/RP0/CPU0:router(config-if)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Step 5 `show interface` *type instance*

Example:

```
RP/0/RP0/CPU0:router# show interfaces Loopback0
```

(Optional) Displays the configuration of the loopback interface.

Example

This example shows how to configure a loopback interface:

```
RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)# interface Loopback0
RP/0/RP0/CPU0:router(config-if)# ipv4 address 100.100.100.69 255.255.255.255
RP/0/RP0/CPU0:router(config-if)# ipv6 address 100::69/128
RP/0/RP0/CPU0:router(config-if)# end
Uncommitted changes found, commit them? [yes]: yes
RP/0/RP0/CPU0:router# show interfaces Loopback0
```

```
Loopback0 is up, line protocol is up
Interface state transitions: 1
Hardware is Loopback interface(s)
Internet address is 100.100.100.69/32
MTU 1500 bytes, BW 0 Kbit
    reliability Unknown, txload Unknown, rxload Unknown
Encapsulation Loopback, loopback not set,
Last link flapped 01:57:47
Last input Unknown, output Unknown
Last clearing of "show interface" counters Unknown
Input/output data rate is disabled.
```

Null Interface Overview

A null interface functions similarly to the null devices available on most operating systems. This interface is always up and can never forward or receive traffic; encapsulation always fails. The null interface provides an alternative method of filtering traffic. You can avoid the overhead involved with using access lists by directing undesired network traffic to the null interface.

The only interface configuration command that you can specify for the null interface is the **ipv4 unreachable** command. With the **ipv4 unreachable** command, if the software receives a non-broadcast packet destined for itself that uses a protocol it does not recognize, it sends an Internet Control Message Protocol (ICMP) protocol unreachable message to the source. If the software receives a datagram that it cannot deliver to its ultimate destination because it knows of no route to the destination address, it replies to the originator of that datagram with an ICMP host unreachable message. By default **ipv4 unreachable** command is enabled. If we do not want ICMP to send protocol unreachable, then we need to configure using the **ipv4 icmp unreachable disable** command.

The Null 0 interface is created by default during boot process and cannot be removed. The **ipv4 unreachable** command can be configured for this interface, but most configuration is unnecessary because this interface just discards all the packets sent to it.

The Null 0 interface can be displayed with the **show interfaces null0** command.

Configuring Null Interfaces

This task explains how to configure a basic null interface.

SUMMARY STEPS

1. **configure**
2. **interface null 0**
3. **end** or **commit**
4. **show interfaces null 0**

DETAILED STEPS

Step 1 **configure****Example:**

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **interface null 0****Example:**

```
RP/0/RP0/CPU0:router(config)# interface null 0
```

Enters the null 0 interface configuration mode.

Step 3 **end** or **commit****Example:**


```
RP/0/RP0/CPU0:router(config-null0)# end
```

or

```
RP/0/RP0/CPU0:router(config-null0)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before
exiting(yes/no/cancel)?
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Step 4 show interfaces null 0

Example:

```
RP/0/RP0/CPU0:router# show interfaces null 0
```

Verifies the configuration of the null interface.

Example

This example shows how to configure a null interface:

```
RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)# interface Null 0
RP/0/RP0/CPU0:router(config-null0)# ipv4 icmp unreachable disable
RP/0/RP0/CPU0:router(config-null0)# end
Uncommitted changes found, commit them? [yes]: yes
RP/0/RP0/CPU0:router# show interfaces Null 0
```

```
Null0 is up, line protocol is up
Interface state transitions: 1
Hardware is Null interface
Internet address is Unknown
MTU 1500 bytes, BW 0 Kbit
reliability 255/255, txload Unknown, rxload Unknown
Encapsulation Null, loopback not set,
Last link flapped 4d20h
Last input never, output never
Last clearing of "show interface" counters 05:42:04
5 minute input rate 0 bits/sec, 0 packets/sec
```

```

5 minute output rate 0 bits/sec, 0 packets/sec
0 packets input, 0 bytes, 0 total input drops
0 drops for unrecognized upper-level protocol
Received 0 broadcast packets, 0 multicast packets
0 packets output, 0 bytes, 0 total output drops
Output 0 broadcast packets, 0 multicast packets

```

Configuring Virtual IPv4 Interfaces

This task explains how to configure an IPv4 virtual interface.

SUMMARY STEPS

1. **configure**
2. **ipv4 virtual address** *ipv4-*
3. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **ipv4 virtual address** *ipv4-*

Example:

```
RP/0/RP0/CPU0:router(config)# ipv4 virtual address 10.3.32.154/8
```

Defines an IPv4 virtual address for the management Ethernet interface.

Step 3 **end** or **commit**

Example:

```
RP/0/RP0/CPU0:router(config-null0)# end
```

or

```
RP/0/RP0/CPU0:router(config-null0)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```

Uncommitted changes found, commit them before
exiting(yes/no/cancel)?
[cancel]:

```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.

- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
 - Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
 - Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.
-

Example

This is an example for configuring a virtual IPv4 interface:

```
RP/0/RP0/CPU0:router# configure  
RP/0/RP0/CPU0:router(config)# ipv4 virtual address 10.3.32.154/8  
RP/0/RP0/CPU0:router(config-null0)# commit
```




CHAPTER 8

Configuring 802.1Q VLAN Interfaces

A VLAN is a group of devices on one or more LANs that are configured so that they can communicate as if they were attached to the same wire, when in fact they are located on a number of different LAN segments. VLANs are very flexible for user and host management, bandwidth allocation, and resource optimization because they are based on logical grouping instead of physical connections.

The IEEE 802.1Q protocol standard addresses the problem of dividing large networks into smaller parts so broadcast and multicast traffic does not consume more bandwidth than necessary. The standard also helps provide a higher level of security between segments of internal networks.

The 802.1Q specification establishes a standard method for inserting VLAN membership information into Ethernet frames. Cisco NCS 5000 Series Router supports VLAN subinterface configuration on 10-Gigabit Ethernet and 100-Gigabit Ethernet interfaces. The range for VLANs is 1-4094.

802.1Q Tagged Frames

The IEEE 802.1Q tag-based VLAN uses an extra tag in the MAC header to identify the VLAN membership of a frame across bridges. This tag is used for VLAN and quality of service (QoS) priority identification. The VLAN ID associates a frame with a specific VLAN and provides the information that switches must process the frame across the network. A tagged frame is four bytes longer than an untagged frame and contains two bytes of Tag Protocol Identifier (TPID) residing within the type and length field of the Ethernet frame and two bytes of Tag Control Information (TCI) which starts after the source address field of the Ethernet frame.

For detailed information on 802.1Q Tagged Frames, see the *References for Carrier Ethernet Model* section in *L2VPN and Ethernet Services Configuration Guide for Cisco NCS 5000 Series Routers*.

- [How to Configure 802.1Q VLAN Interfaces, on page 123](#)
- [Information About Configuring 802.1Q VLAN Interfaces, on page 129](#)

How to Configure 802.1Q VLAN Interfaces

This section contains the following procedures:

Configuring 802.1Q VLAN Subinterfaces

This task explains how to configure 802.1Q VLAN subinterfaces. To remove these subinterfaces, see the “Removing an 802.1Q VLAN Subinterface” section.

SUMMARY STEPS

1. **configure**
2. **interface {TenGigE | FortyGigE | HundredGigE | Bundle-Ether} interface-path-id.subinterface**
3. **encapsulation dot1q**
4. **ipv4 address ip-address mask**
5. **exit**
6. Repeat Step 2 through Step 5 to define the rest of the VLAN subinterfaces.
7. **end** or **commit**
8. **show ethernet trunk bundle-ether instance**

DETAILED STEPS**Step 1** **configure****Example:**

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **interface {TenGigE | FortyGigE | HundredGigE | Bundle-Ether} interface-path-id.subinterface****Example:**

```
RP/0/RP0/CPU0:router(config)# interface TenGigE 0/2/0/4.10
```

Enters subinterface configuration mode and specifies the interface type, location, and subinterface number.

- Replace the *interface-path-id* argument with one of the following instances:
 - Physical Ethernet interface instance, or with an Ethernet bundle instance. Naming notation is *rack/slot/module/port*, and a slash between values is required as part of the notation.
 - Ethernet bundle instance. Range is from 1 through 65535.
- Replace the *subinterface* argument with the subinterface value. Range is from 0 through 2147483647.
- Naming notation is *interface-path-id.subinterface*, and a period between arguments is required as part of the notation.

Step 3 **encapsulation dot1q****Example:**

```
RP/0/RP0/CPU0:router(config-subif)# encapsulation dot1q 100
```

Sets the Layer 2 encapsulation of an interface.

Step 4 **ipv4 address ip-address mask****Example:**

```
RP/0/RP0/CPU0:router(config-subif)# ipv4 address 178.18.169.23/24
```

Assigns an IP address and subnet mask to the subinterface.

- Replace *ip-address* with the primary IPv4 address for an interface.
- Replace *mask* with the mask for the associated IP subnet. The network mask can be specified in either of two ways:
- The network mask can be a four-part dotted decimal address. For example, 255.0.0.0 indicates that each bit equal to 1 means that the corresponding address bit belongs to the network address.
- The network mask can be indicated as a slash (/) and number. For example, /8 indicates that the first 8 bits of the mask are ones, and the corresponding bits of the address are network address.

Step 5 **exit****Example:**

```
RP/0/RP0/CPU0:router(config-subif)# exit
```

(Optional) Exits the subinterface configuration mode.

- The **exit** command is not explicitly required.

Step 6 Repeat Step 2 through Step 5 to define the rest of the VLAN subinterfaces.

—

Step 7 **end** or **commit****Example:**

```
RP/0/RP0/CPU0:router(config)# end
```

or

```
RP/0/RP0/CPU0:router(config)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?  
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.

- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.

- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Step 8 **show ethernet trunk bundle-ether** *instance***Example:**

```
RP/0/RP0/CPU0:router# show ethernet trunk bundle-ether 5
```

(Optional) Displays the interface configuration.

The Ethernet bundle instance range is from 1 through 65535.

Verification

This example shows how to verify the configuration of Ethernet interfaces :

```
# show ethernet trunk be 1020 Wed May 17 16:43:32.804 EDT
```

Trunk Interface	St Ly	MTU	Subs	Sub types		Sub states		
				L2	L3	Up	Down	Ad-Down
BE1020	Up L3	9100	3	3	0	3	0	0
Summary			3	3	0	3	0	0

Configuring an Attachment Circuit on a VLAN

Use the following procedure to configure an attachment circuit on a VLAN.

SUMMARY STEPS

1. **configure**
2. **interface [GigabitEthernet | TenGigE | Bundle-Ether | FortyGigE] interface-path id.subinterface l2transport**
3. **encapsulation dot1q 100**
4. **end** or **commit**
5. **show interfaces [GigabitEthernet | FortyGigE | Bundle-Ether | TenGigE] interface-path-id.subinterface**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0//CPU0:router# configure
```

Enters global configuration mode.

Step 2 **interface [GigabitEthernet | TenGigE | Bundle-Ether | FortyGigE] interface-path id.subinterface l2transport**

Example:

```
RP/0//CPU0:router(config)# interface TenGigE 0/1/0/0.1 l2transport
```

Enters subinterface configuration and specifies the interface type, location, and subinterface number.

- Replace the *interface-path-id* argument with one of the following instances:
- Physical Ethernet interface instance, or with an Ethernet bundle instance. Naming notation is *rack/slot/module/port*, and a slash between values is required as part of the notation.
- Ethernet bundle instance. Range is from 1 through 65535.

- Replace the *subinterface* argument with the subinterface value. Range is from 0 through 4095.
- Naming notation is *instance.subinterface*, and a period between arguments is required as part of the notation.
- You must include the **l2transport** keyword in the command string; otherwise, the configuration creates a Layer 3 subinterface rather than an AC.

Step 3 **encapsulation dot1q 100****Example:**

```
RP/0//CPU0:router (config-subif)# encapsulation dot1q 100
```

Sets the Layer 2 encapsulation of an interface.

Note The **dot1q vlan** command is replaced by the **encapsulation dot1q** command. It is still available for backward-compatibility, but only for Layer 3 interfaces.

Step 4 **end or commit****Example:**

```
RP/0//CPU0:router (config-if-l2)# end
```

or

```
RP/0//CPU0:router (config-if-l2)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?  
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.

- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.

- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Step 5 **show interfaces [GigabitEthernet | FortyGigE | Bundle-Ether | TenGigE] interface-path-id.subinterface****Example:**

```
RP/0//CPU0:router# show interfaces TenGigE 0/3/0/0.1
```

(Optional) Displays statistics for interfaces on the router.

Removing an 802.1Q VLAN Subinterface

This task explains how to remove 802.1Q VLAN subinterfaces that have been previously configured using the Configuring 802.1Q VLAN subinterfaces section in this module.

SUMMARY STEPS

1. **configure**
2. **no interface** {TenGigE | FortyGigE | HundredGigE | Bundle-Ether} *interface-path-id.subinterface*
3. Repeat Step 2 to remove other VLAN subinterfaces.
4. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **no interface** {TenGigE | FortyGigE | HundredGigE | Bundle-Ether} *interface-path-id.subinterface*

Example:

```
RP/0/RP0/CPU0:router(config)# no interface TenGigE 0/2/0/4.10
```

Removes the subinterface, which also automatically deletes all the configuration applied to the subinterface.

- Replace the *instance* argument with one of the following instances:
 - Physical Ethernet interface instance, or with an Ethernet bundle instance. Naming notation is *rack/slot/module/port*, and a slash between values is required as part of the notation.
 - Ethernet bundle instance. Range is from 1 through 65535.
 - Replace the *subinterface* argument with the subinterface value. Range is from 0 through 2147483647.

Naming notation is *instance.subinterface*, and a period between arguments is required as part of the notation.

Step 3 Repeat Step 2 to remove other VLAN subinterfaces.

Step 4 **end** or **commit**

Example:

```
RP/0/RP0/CPU0:router(config)# end
```

or

```
RP/0/RP0/CPU0:router(config)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?  
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
 - Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
 - Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Information About Configuring 802.1Q VLAN Interfaces

To configure 802.1Q VLAN interfaces, you must understand these concepts:

Subinterfaces

Subinterfaces are logical interfaces created on a hardware interface. These software-defined interfaces allow for segregation of traffic into separate logical channels on a single hardware interface as well as allowing for better utilization of the available bandwidth on the physical interface.

Subinterfaces are distinguished from one another by adding an extension on the end of the interface name and designation. For instance, the Ethernet subinterface 23 on the physical interface designated TenGigE 0/1/0/0 would be indicated by TenGigE 0/1/0/0.23.

Before a subinterface is allowed to pass traffic it must have a valid tagging protocol encapsulation and VLAN identifier assigned. All Ethernet subinterfaces always default to the 802.1Q VLAN encapsulation. However, the VLAN identifier must be explicitly defined.

These are the applicable scale values for sub-interfaces:

- Sub-interface per system = 1024
- Sub-interface per line card = 1024
- Sub-interface per NPU = 1024
- Sub-interface per interface = 512
- Sub-Interface per Core = 512

Subinterface MTU

The subinterface maximum transmission unit (MTU) is inherited from the physical interface with an additional four bytes allowed for the 802.1Q VLAN tag. By default subinterface inherits MTU of physical interface if

the MTU is not configured. We can have maximum 3 different MTU for a subinterface per NPU. For information about Ethernet MTU and Flow Control on Ethernet interfaces, see *References for Carrier Ethernet Model* section in *L2VPN and Ethernet Services Configuration Guide for Cisco NCS 5000 Series Routers*.

EFPs

An Ethernet Flow Point (EFP) is a Metro Ethernet Forum (MEF) term describing abstract router architecture. An EFP is implemented by an Layer 2 subinterface with a VLAN encapsulation. The term EFP is used synonymously with an VLAN tagged L2 subinterface. For more information on EFPs, see the *Carrier Ethernet Model* chapter in *L2VPN and Ethernet Services Configuration Guide for Cisco NCS 5000 Series Routers*.

Layer 2 VPN on VLANs

The Layer 2 Virtual Private Network (L2VPN) feature enables Service Providers (SPs) to provide Layer 2 services to geographically disparate customer sites.

The configuration model for configuring VLAN attachment circuits (ACs) is similar to the model used for configuring basic VLANs, where the user first creates a VLAN subinterface, and then configures that VLAN in subinterface configuration mode. To create an AC, you need to include the **l2transport** keyword in the **interface** command string to specify that the interface is a Layer 2 interface.

VLAN ACs support these modes of L2VPN operation:

- Basic Dot1Q AC—The AC covers all frames that are received and sent with a specific VLAN tag.
- QinQ AC—The AC covers all frames received and sent with a specific outer VLAN tag and a specific inner VLAN tag. QinQ is an extension to Dot1Q that uses a stack of two tags.

Each VLAN on a CE-to-PE link can be configured as a separate L2VPN connection (using either VC type 4 or VC type 5).

For more information about Layer 2 VPN on VLANs and their configuration, see the *Implementing Point-to-Point Layer 2 Services* chapter in *L2VPN and Ethernet Services Configuration Guide for Cisco NCS 5000 Series Routers*.

Layer 3 QinQ

Layer 3 QinQ is an extension of IEEE 802.1 QinQ VLAN tag stacking. This feature enables you to increase the number of VLAN tags in an interface and increments the number of sub-interfaces up to 4094. Hence, with dual tag, the number of VLANs can reach up to 4094*4094. With the L3 QinQ feature with dual tag, interfaces check for IP addresses along with MAC addresses.

This feature supports:

- 802.1Q standards like 0x8100, 0x9100, 0x9200 (used as outer tag ether-type) and 0x8100 (used as inner tag ether-type).
- L3 802.1ad VLAN sub-interfaces, with 0x88a8 as the outer S-tag ether-type.
- Co-existence of L2 and L3 single tagged and double tagged VLANs.
- QinQ and dot1ad over ethernet bundle sub-interfaces.
- Default VRF.



Note QinQ sub-interfaces support these IP features:

- QoS, with policy that matches outer VLAN (and COS) alone, and not both outer and inner VLANs together (2-level QoS/H-QoS support).
- ACL, Netflow, BFD, ARP.
- Routing protocols – static, BGP, OSFPv2.
- IPV4/IPV6 unicast/multicast.

Prerequisites:

1. Enable QinQ dual tag support on L3 sub-interfaces on the NSC 5500 and NCS 560 platforms.
2. Ensure the sub-interface scale is the same as what is supported per platform on single tag/802.1Q case. L3 QinQ feature is enabled on physical interfaces as well as on bundle interfaces.



Note Types of sub-interfaces:

Interface type	Outer tag	Inner tag
Dot1q sub-interface	0x8100	None
QinQ sub-interface	0x8100	0x8100
QinQ sub-interface	0x88a8	0x8100
QinQ sub-interface	0x9100	0x8100
QinQ sub-interface	0x9200	0x8100

Limitations:

MPLS is not supported.

Example:

```
Example 1:
interface TenGigE0/0/0/6.111
mtu 1400
ipv4 address 10.1.1.1 255.255.255.0
ipv6 address 10::1/64
encapsulation dot1q 100 second-dot1q 200
!

interface Bundle-Ether10.1
ipv4 address 10.1.2.1 255.255.255.0
ipv6 address 1002::1/64
encapsulation dot1ad 10 second-dot1q 20
!
```

Example 2:

```
Router(config)# interface gigabitethernet 1/0/0
Router(config-if)# dot1q tunneling ethertype 0x9100
Router(config-if)# interface gigabitethernet 1/0/0.1
Router(config-subif)# encapsulation dot1q 100 second-dot1q 200
Router(config-subif)# ipv4 address 172.16.1.2 255.255.255.0
```

Example 3:

```
interface GigabitEthernet0/7/0/2.100
description ** Business Services over DOCSIS **
encapsulation dot1q 100 second-dot1q 200-500
ipv4 address 192.168.212.6 255.255.255.252
```

Example 4:

```
interface Bundle-Ether1.2
description cliente: NUOVA JOLLY MARINE S.R.L. TD: null NUA: null TGU: 100213581081
encapsulation dot1q 3200 second-dot1q 2
ipv4 address 85.42.169.6 255.255.255.252
service-policy input BIZDSLIP_HSIHYP_NOBP_96KBMG
```



CHAPTER 9

Implementing Integrated Routing and Bridging

IRB provides the ability to route between a bridge group and a routed interface using a BVI. The BVI is a virtual interface within the router that acts like a normal routed interface. A BVI is associated with a single bridge domain and represents the link between the bridging and the routing domains on the router. To support receipt of packets from a bridged interface that are destined to a routed interface, the BVI must be configured with the appropriate IP addresses and relevant Layer 3 attributes.

- [Bridge-Group Virtual Interface, on page 133](#)
- [Sub-Interfaces with BVI interface in Bridge Domain, on page 134](#)
- [Supported Features on a BVI, on page 134](#)
- [BVI Interface and Line Protocol States, on page 134](#)
- [Prerequisites for Configuring IRB, on page 135](#)
- [Restrictions for Configuring IRB, on page 135](#)
- [How to Configure IRB, on page 135](#)
- [Additional Information on IRB, on page 144](#)
- [Packet Flows Using IRB, on page 144](#)
- [Configuration Examples for IRB, on page 146](#)

Bridge-Group Virtual Interface

The BVI is a virtual interface within the router that acts like a normal routed interface. The BVI does not support bridging itself, but acts as a gateway for the corresponding bridge-domain to a routed interface within the router.

Aside from supporting a configurable MAC address, a BVI supports only Layer 3 attributes, and has the following characteristics:

- Uses a MAC address taken from the local chassis MAC address pool, unless overridden at the BVI interface.
- Is configured as an interface type using the **interface bvi** command and uses an IPv4 address that is in the same subnet as the hosts on the segments of the bridged domain. The BVI also supports secondary addresses.
- The BVI identifier is independent of the bridge-domain identifier. These identifiers do not need to correlate like they do in Cisco IOS software.
- Is associated to a bridge group using the **routed interface bvi** command.

Sub-Interfaces with BVI interface in Bridge Domain

Support for Layer 2 (L2) sub-interfaces to work with BVI interface in a bridge domain has been added in the Cisco IOS XR Software Release 6.3.1. The L2 sub-interfaces must have a rewrite configuration to pop the outer tag in Ingress direction and push the outer tag on the packet in egress direction. The outer tag that is to be pushed in egress direction is based on the interface encapsulation. The support is added only for single tag sub-interfaces. Double tagged sub-interfaces that work with BVI interface in a bridge domain are not supported.

Supported Features on a BVI

- These interface commands are supported on a BVI:
 - **arp purge-delay**
 - arp timeout
 - **bandwidth** (The default is 10 Gbps and is used as the cost metric for routing protocols for the BVI)
 - **ipv4**
 - **ipv6**
 - **mac-address**
 - **mtu** (The default is 1500 bytes)
 - **shutdown**
- The BVI supports IP helper addressing and secondary IP addressing.

BVI Interface and Line Protocol States

Like typical interface states on the router, a BVI has both an Interface and Line Protocol state.

- The BVI interface state is Up when the following occurs:
 - The BVI interface is created.
 - The bridge-domain that is configured with the **routed interface bvi** command has at least one available active bridge port .
- These characteristics determine when the the BVI line protocol state is up:
 - The bridge-domain is in Up state.
 - The BVI IP address is not in conflict with any other IP address on another active interface in the router.

Prerequisites for Configuring IRB

You must be in a user group associated with a task group that includes the proper task IDs. The command reference guides include the task IDs required for each command. If you suspect user group assignment is preventing you from using a command, contact your AAA administrator for assistance.

Before configuring IRB, be sure that these tasks and conditions are met:

- Know the IP addressing and other Layer 3 information to be configured on the bridge virtual interface (BVI).
- Complete MAC address planning if you decide to override the common global MAC address for all BVIs.
- Be sure that the BVI network address is being advertised by running static or dynamic routing on the BVI interface.

Restrictions for Configuring IRB

Before configuring IRB, consider these restrictions:

- Only one BVI can be configured in any bridge domain.
- The same BVI can not be configured in multiple bridge domains.
- The following areas are *not* supported on the Layer2 bridging (with BVI):
 - Access Control Lists (ACLs). However, Layer 2 ACLs can be configured on each Layer 2 port of the bridge domain.
 - Static mac entry configuration in Bridge.
 - Mac ageing configuration at global config mode.
 - MAC Learning Disable.
 - Port-channel sub-interface as bridge member.
 - Physical sub-interface as bridge member.
 - Vlan rewrite.
- QoS configuration on BVI interface is not supported.
- VRF on BVI interface is not supported.

How to Configure IRB

This section includes the following configuration tasks:

Configuring the Bridge Group Virtual Interface

To configure a BVI, complete the following steps.

Configuration Guidelines

Consider the following guidelines when configuring the BVI:

- The BVI must be assigned an IPv4 or IPv6 address that is in the same subnet as the hosts in the bridged segments.
- If the bridged network has multiple IP networks, then the BVI must be assigned secondary IP addresses for each network.

SUMMARY STEPS

1. **configure**
2. **interface bvi** *identifier*
3. **ipv4 address** *ipv4-address mask* [**secondary**] **ipv6 address** *ipv6-prefix/prefix-length* [**eui-64**] [**route-tag** *route-tag value*]
4. **arp purge-delay** *seconds*
5. **arp timeout** *seconds*
6. **bandwidth** *rate*
7. **mac-address** *value1.value2.value3*
8. **mtu** *bytes*
9. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters the global configuration mode.

Step 2 **interface bvi** *identifier*

Example:

```
RP/0/RP0/CPU0:router(config)# interface bvi 1
```

Specifies or creates a BVI, where *identifier* is a number from 1 to 65535.

Step 3 **ipv4 address** *ipv4-address mask* [**secondary**] **ipv6 address** *ipv6-prefix/prefix-length* [**eui-64**] [**route-tag** *route-tag value*]

Example:

```
RP/0/RP0/CPU0:router(config-if)# ipv4 address 10.10.0.4 255.255.255.0
```

Specifies a primary or secondary IPv4 address or an IPv6 address for an interface.

Step 4 **arp purge-delay** *seconds***Example:**

```
RP/0/RP0/CPU0:router(config-if)#arp purge-delay 120
```

(Optional) Specifies the amount of time (in *seconds*) to delay purging of Address Resolution Protocol (ARP) table entries when the interface goes down.

The range is 1 to 65535. By default purge delay is not configured.

Step 5 **arp timeout** *seconds***Example:**

```
RP/0/RP0/CPU0:router(config-if)# arp timeout 12200
```

(Optional) Specifies how long dynamic entries learned on the interface remain in the ARP cache.

The range is 30 to 2144448000 seconds. The default is 14,400 seconds (4 hours).

Step 6 **bandwidth** *rate***Example:**

```
RP/0/RP0/CPU0:router(config-if)# bandwidth 1000000
```

(Optional) Specifies the amount of bandwidth (in kilobits per second) to be allocated on the interface. This number is used as the cost metric in routing protocols for the BVI.

The range is 0 to 4294967295. The default is 10000000 (10 Gbps).

Step 7 **mac-address** *value1.value2.value3***Example:**

```
RP/0/RP0/CPU0:router(config-if)# mac-address 1111.2222.3333
```

(Optional) Specifies the 48-bit MAC address for the BVI as three dotted-hexadecimal values, and overrides use of the default MAC address. The range for each value is 0000 to ffff. A MAC address of all 0s is not supported.

Step 8 **mtu** *bytes***Example:**

```
RP/0/RP0/CPU0:router(config-if)# mtu 2000
```

(Optional) Specifies the maximum transmission unit (MTU) size for packets on the interface. The range is 64 to 65535. The default is 1514.

Step 9 **end** or **commit****Example:**

```
RP/0/RP0/CPU0:router(config-if)# end
```

or

```
RP/0/RP0/CPU0:router(config-if)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?
[cancel]:
```

Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.

Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.

Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring the Layer 2 AC Interfaces

To configure the Layer 2 AC interfaces for routing by a BVI, complete the following steps.

SUMMARY STEPS

1. **configure**
2. **interface [HundredGigE | TenGigE] interface-path-id l2transport**
3. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **interface [HundredGigE | TenGigE] interface-path-id l2transport**

Example:

```
RP/0/RP0/CPU0:router(config)# interface HundredGigE 0/1/0/3 l2transport
```

Enables Layer 2 transport mode on interface, where *interface-path-id* is specified as the *rack/slot/module/port* location of the interface .

Step 3 **end** or **commit**

Example:

```
RP/0/RP0/CPU0:router(config-if)# end
```

or

```
RP/0/RP0/CPU0:router(config-if)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?  
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configuring a Bridge Group and Assigning Interfaces to a Bridge Domain

To configure a bridge group and assign interfaces to a bridge domain, complete the following steps.

SUMMARY STEPS

1. **configure**
2. **l2vpn**
3. **bridge group** *bridge-group-name*
4. **bridge-domain** *bridge-domain-name*
5. **interface** [**HundredGigE** | **TenGigE**] *interface-path-id*
6. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **l2vpn**

Example:

```
RP/0/RP0/CPU0:router(config)# l2vpn
```

Enters L2VPN configuration mode.

Step 3 **bridge group** *bridge-group-name*

Example:

```
RP/0/RP0/CPU0:router(config-l2vpn)# bridge group 10
```

Creates a bridge group and enters L2VPN bridge group configuration mode.

Step 4 **bridge-domain** *bridge-domain-name*

Example:

```
RP/0/RP0/CPU0:router(config-l2vpn-bg)# bridge-domain BD_1
```

Creates a bridge domain and enters L2VPN bridge group bridge domain configuration mode.

Step 5 **interface** [**HundredGigE** | **TenGigE**] *interface-path-id*

Example:

```
RP/0/RP0/CPU0:router(config-l2vpn-bg-bd)# interface HundredGigE 0/1/0/3
```

Associates the 100-Gigabit Ethernet or 10-Gigabit Ethernet interface with the specified bridge domain and enters L2VPN bridge group bridge domain attachment circuit configuration mode, where *interface-path-id* is specified as the *rack/slot/module/port* location of the interface.

Repeat this step for as many interfaces as you want to associate with the bridge domain.

Step 6 **end** or **commit**

Example:

```
RP/0/RP0/CPU0:router(config-l2vpn-bg-bd-ac)# end
```

or

```
RP/0/RP0/CPU0:router(config-l2vpn-bg-bd-ac)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.

- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Configure the Layer 2 AC Sub-Interfaces

To configure the Layer 2 AC sub-interfaces for routing by a BVI, complete the following steps.

```
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# interface TenGigE0/0/0/0.1 l2transport
RP/0/RSP0/CPU0:router(config-subif)# encapsulation dot1q 100
RP/0/RSP0/CPU0:router(config-subif)# rewrite ingress tag pop 1 symmetric
```

Running Configuration

```
configure
interface TenGigE0/0/0/0.1 l2transport
encapsulation dot1q 100
rewrite ingress tag pop 1 symmetric
```

Verification

Verify configuration of layer 2 AC sub-interface.

```
RP/0/RP0/CPU0:ios# show running interface TenGigE 0/0/0/0.1
Wed Jul 26 13:40:50.173 UTC

interface TenGigE0/0/0/0.1 l2transport
encapsulation dot1q 100
rewrite ingress tag pop 1 symmetric
```

Configure a Bridge Group and Assign Sub-Interfaces to a Bridge Domain

To configure a bridge group and assign a sub-interface to a bridge domain, complete the following steps.

```
RP/0/RSP0/CPU0:router# configure
RP/0/RSP0/CPU0:router(config)# l2vpn
RP/0/RSP0/CPU0:router(config-l2vpn)# bridge group 1
RP/0/RSP0/CPU0:router(config-l2vpn-bg)# bridge-domain bd1
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# bridge-domain bd1
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-ac)# interface TenGigE 0/0/0/0.1
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd-ac)# exit
RP/0/RSP0/CPU0:router(config-l2vpn-bg-bd)# routed interface BVI1
```

Running Configuration

```
configure
l2vpn
```

```

bridge group 1
  bridge-domain BD1
    interface TenGigE0/0/0/0.1
    !
  routed interface BVI1
  !

```

Verification

Verify the configuration of the bridge group and assignment of a sub-interface to bridge-domain.

```
RP/0/RP0/CPU0:ios#show running l2vpn
```

```

Wed Jul 26 13:38:32.830 UTC
l2vpn
bridge group 1
  bridge-domain BD1
    interface TenGigE 0/0/0/0.1
    !
  routed interface BVI1
  !

```

Associating the BVI as the Routed Interface on a Bridge Domain

To associate the BVI as the routed interface on a bridge domain, complete the following steps.

SUMMARY STEPS

1. **configure**
2. **l2vpn**
3. **bridge group** *bridge-group-name*
4. **bridge-domain** *bridge-domain-name*
5. **routed interface bvi** *identifier*
6. **end** or **commit**

DETAILED STEPS

Step 1 **configure**

Example:

```
RP/0/RP0/CPU0:router# configure
```

Enters global configuration mode.

Step 2 **l2vpn**

Example:

```
RP/0/RP0/CPU0:router(config)# l2vpn
```

Enters L2VPN configuration mode.

Step 3 `bridge group` *bridge-group-name***Example:**

```
RP/0/RP0/CPU0:router(config-l2vpn)# bridge group BG_test
```

Creates a bridge group and enters L2VPN bridge group configuration mode.

Step 4 `bridge-domain` *bridge-domain-name***Example:**

```
RP/0/RP0/CPU0:router(config-l2vpn-bg)# bridge-domain 1
```

Creates a bridge domain and enters L2VPN bridge group bridge domain configuration mode.

Step 5 `routed interface bvi` *identifier***Example:**

```
RP/0/RP0/CPU0:router(config-l2vpn-bg-bd)# routed interface bvi 1
```

Associates the specified BVI as the routed interface for the interfaces assigned to the bridge domain.

Step 6 `end` or `commit`**Example:**

```
RP/0/RP0/CPU0:router(config-l2vpn-bg-bd)# end
```

or

```
RP/0/RP0/CPU0:router(config-l2vpn-bg-bd)# commit
```

Saves configuration changes.

- When you issue the **end** command, the system prompts you to commit changes:

```
Uncommitted changes found, commit them before exiting(yes/no/cancel)?  
[cancel]:
```

- Entering **yes** saves configuration changes to the running configuration file, exits the configuration session, and returns the router to EXEC mode.
- Entering **no** exits the configuration session and returns the router to EXEC mode without committing the configuration changes.
- Entering **cancel** leaves the router in the current configuration session without exiting or committing the configuration changes.
- Use the **commit** command to save the configuration changes to the running configuration file and remain within the configuration session.

Displaying Information About a BVI

To display information about BVI status and packet counters, use the following commands:

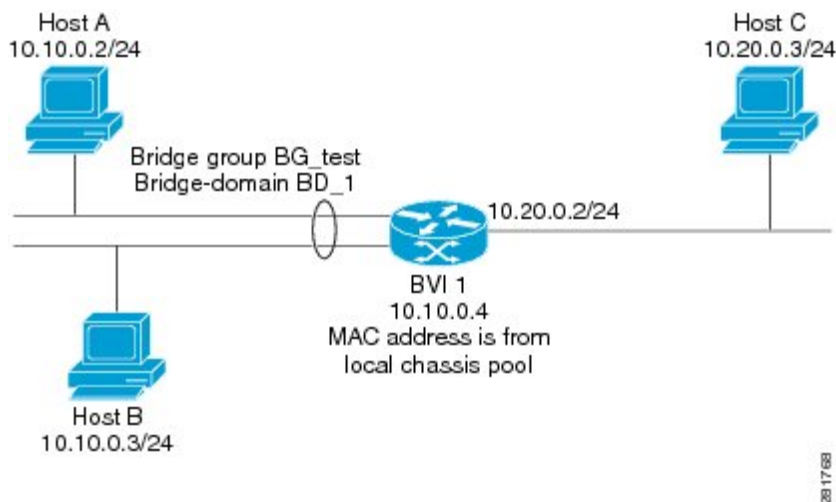
show interfaces bvi <i>identifier</i> [accounting brief description detail]	Displays interface status, line protocol state, and packet counters for the specified BVI.
show adjacency bvi <i>identifier</i> [detail remote]	Displays packet and byte transmit counters per adjacency to the specified BVI.
show l2vpn bridge-domain detail	Displays the reason that a BVI is down.

Additional Information on IRB

Packet Flows Using IRB

This figure shows a simplified functional diagram of an IRB implementation to describe different packet flows between Host A, B, and C. In this example, Host C is on a network with a connection to the same router. In reality, another router could be between Host C and the router shown.

Figure 20: IRB Packet Flows Between Hosts



When IRB is configured on a router, the following processing happens:

- ARP requests are resolved between the hosts and BVI that are part of the bridge domain.
- All packets from a host on a bridged interface go to the BVI if the destination MAC address matches the BVI MAC address. Otherwise, the packets are bridged.
- For packets destined for a host on a routed network, the BVI forwards the packets to the routing engine before sending them out a routed interface.
- All packets either from or destined to a host on a bridged interface go to the BVI first (unless the packet is destined for a host on the bridge domain).
- For packets that are destined for a host on a segment in the bridge domain that come in to the router on a routed interface, the BVI forwards the packet to the bridging engine, which forwards it through the appropriate bridged interface.

Packet Flows When Host A Sends to Host B on the Bridge Domain

When Host A sends data to Host B in the bridge domain on the 10.10.0.0 network, no routing occurs. The hosts are on the same subnet and the packets are bridged between their segment interfaces on the router.

Packet Flows When Host A Sends to Host C From the Bridge Domain to a Routed Interface

Using host information from this figure, the following occurs when Host A sends data to Host C from the IRB bridging domain to the routing domain:

- Host A sends the packet to the BVI (as long as any ARP request is resolved between the host and the BVI). The packet has the following information:
 - Source MAC address of host A.
 - Destination MAC address of the BVI.
- Since Host C is on another network and needs to be routed, the BVI forwards the packet to the routed interface with the following information:
 - IP source MAC address of Host A (10.10.0.2) is changed to the MAC address of the BVI (10.10.0.4).
 - IP destination address is the IP address of Host C (10.20.0.3).
- Interface 10.20.0.2 sees receipt of a packet from the routed BVI 10.10.0.4. The packet is then routed through interface 10.20.0.2 to Host C.

Packet Flows When Host C Sends to Host B From a Routed Interface to the Bridge Domain

Using host information from this figure, the following occurs when Host C sends data to Host B from the IRB routing domain to the bridging domain:

- The packet comes into the routing domain with the following information:
 - MAC source address—MAC of Host C.
 - MAC destination address—MAC of the 10.20.0.2 ingress interface.
 - IP source address—IP address of Host C (10.20.0.3).
 - IP destination address—IP address of Host B (10.10.0.3).
- When interface 10.20.0.2 receives the packet, it looks in the routing table and determines that the packet needs to be forwarded to the BVI at 10.10.0.4.
- The routing engine captures the packet that is destined for the BVI and forwards it to the BVI's corresponding bridge domain. The packet is then bridged through the appropriate interface if the destination MAC address for Host B appears in the bridging table, or is flooded on all interfaces in the bridge group if the address is not in the bridging table.

Configuration Examples for IRB

This section provides the following configuration examples:

Basic IRB Configuration: Example

The following example shows how to perform the most basic IRB configuration:

```

! Configure the BVI and its IPv4 address
!
RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)#interface bvi 1
RP/0/RP0/CPU0:router(config-if)#ipv4 address 10.10.0.4 255.255.255.0
RP/0/RP0/CPU0:router(config-if)# exit
!
! Configure the Layer 2 AC interface
!
RP/0/RP0/CPU0:router(config)#interface HundredGigE 0/1/0/0 l2transport
RP/0/RP0/CPU0:router(config-if)# exit
!
! Configure the L2VPN bridge group and bridge domain and assign interfaces
!
RP/0/RP0/CPU0:router(config)#l2vpn
RP/0/RP0/CPU0:router(config-l2vpn)#bridge group 10
RP/0/RP0/CPU0:router(config-l2vpn-bg)#bridge-domain 1
RP/0/RP0/CPU0:router(config-l2vpn-bg-bd)#interface HundredGigE 0/1/0/0
RP/0/RP0/CPU0:router(config-l2vpn-bg-bd-if)# exit
!
! Associate a BVI to the bridge domain
!
RP/0/RP0/CPU0:router(config-l2vpn-bg-bd)# routed interface bvi 1
RP/0/RP0/CPU0:router(config-l2vpn-bg-bd)# commit

```

IPv4 Addressing on a BVI Supporting Multiple IP Networks: Example

The following example shows how to configure secondary IPv4 addresses on a BVI that supports bridge domains for the 10.10.10.0/24, 10.20.20.0/24, and 10.30.30.0/24 networks. In this example, the BVI must have an address on each of the bridge domain networks:

```

RP/0/RP0/CPU0:router# configure
RP/0/RP0/CPU0:router(config)#interface bvi 1
RP/0/RP0/CPU0:router(config-if)#ipv4 address 10.10.10.4 255.255.255.0
RP/0/RP0/CPU0:router(config-if)#ipv4 address 10.20.20.4 255.255.255.0 secondary
RP/0/RP0/CPU0:router(config-if)#ipv4 address 10.30.30.4 255.255.255.0 secondary
RP/0/RP0/CPU0:router(config-if)# commit

```