Configuring Ethernet Connectivity Fault Management in a Service Provider Network

Ethernet Connectivity Fault Management (CFM) is an end-to-end per-service-instance Ethernet layer operations, administration, and maintenance (OAM) protocol. It includes proactive connectivity monitoring, fault verification, and fault isolation for large Ethernet metropolitan-area networks (MANs) and WANs.

The advent of Ethernet as a MAN and WAN technology imposes a new set of OAM requirements on Ethernet's traditional operations, which were centered on enterprise networks only. The expansion of Ethernet technology into the domain of service providers, where networks are substantially larger and more complex than enterprise networks and the user base is wider, makes operational management of link uptime crucial. More importantly, the timeliness in isolating and responding to a failure becomes mandatory for normal day-to-day operations, and OAM translates directly to the competitiveness of the service provider.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for Configuring Ethernet CFM in a Service Provider Network

Business Requirements

- Network topology and network administration have been evaluated.
- Business and service policies have been established.
- Partial Route Computation (PRC) codes have been implemented for all supported commands related to configuring High Availability (HA) on a maintenance endpoint (MEP), maintenance intermediate point (MIP), level, service instance ID, cross-check timer, cross-check, and domain.

Restrictions for Configuring Ethernet CFM

Restrictions for RSP3 Module

- For Maintenance Association in string format and for timers lesser than 1 second, configure as below:
    - Domain name is strictly 5 bytes (exactly 5 characters can only used as domain name).
    - Maintenance Association name can vary from 1 to 6 bytes (service name can be any value only between 1 to 6 characters).
- Port-MEP is *not* supported on a interface having untagged EFP.
- For offloaded Maintenance Association, CCM threshold cannot be changed; the default value is 3.5.
- If UP MEP CFM session are configured on a physically down interface, the Remote MEP is not learnt till the interface comes up.
- Dynamically adding BDI for a TEFP bridge domain can cause traffic disruption and flaps for CFM sessions configured on TEFP for the same bridge domain.
- Toggling of CC interval from HW (3.3ms, 100ms, 10ms) to SW (1s, 10s) could cause the Local MEP programming to fail. We recommend you remove and reconfigure the MEP.
- UP MEP is *not* supported if port-channel interface is in shutdown mode, the MEPs is *not* learnt and CCM packets are *not* sent.
- Currently UP MEP on port-channel inteface is supported only on the first 24 port-channel interfaces, Po1 to Po24.
- DOWN MEP is supported on all port-channels.
- Port MEP is not supported on port-channel member-links.
- CFM is *not* HA and ISSU aware.
- TCAM entries are added in the Egress ACL region for MIP/MEP configured on TEFP. The following table lists the maximum scale of MIP/MEP configured on the node.

Level	Maximum Number of MEPs
0	239
1	239
2	159
3	239
4	159
5	159
6	119
7	239

Note Number of MIP entries is based on the number of VLANs specified in the MIP configuration. The MIP/MEP under TEFP is also inclusive in the maximum number of MEPS on the node (1024).

Information About Configuring Ethernet CFM in a Service Provider Network

Ethernet CFM

Ethernet CFM is an end-to-end per-service-instance Ethernet layer OAM protocol that includes proactive connectivity monitoring, fault verification, and fault isolation. End to end can be PE to PE or CE to CE. A service can be identified as a service provider VLAN (S-VLAN) or an EVC service.

Being an end-to-end technology is the distinction between CFM and other metro-Ethernet OAM protocols. For example, MPLS, ATM, and SONET OAM help in debugging Ethernet wires but are not always end-to-end. 802.3ah OAM is a single-hop and per-physical-wire protocol. It is not end to end or service aware.

Troubleshooting carrier networks offering Ethernet Layer 2 services is challenging. Customers contract with service providers for end-to-end Ethernet service and service providers may subcontract with operators to provide equipment and networks. Compared to enterprise networks, where Ethernet traditionally has been implemented, these constituent networks belong to distinct organizations or departments, are substantially larger and more complex, and have a wider user base. Ethernet CFM provides a competitive advantage to service providers for which the operational management of link uptime and timeliness in isolating and responding to failures is crucial to daily operations.

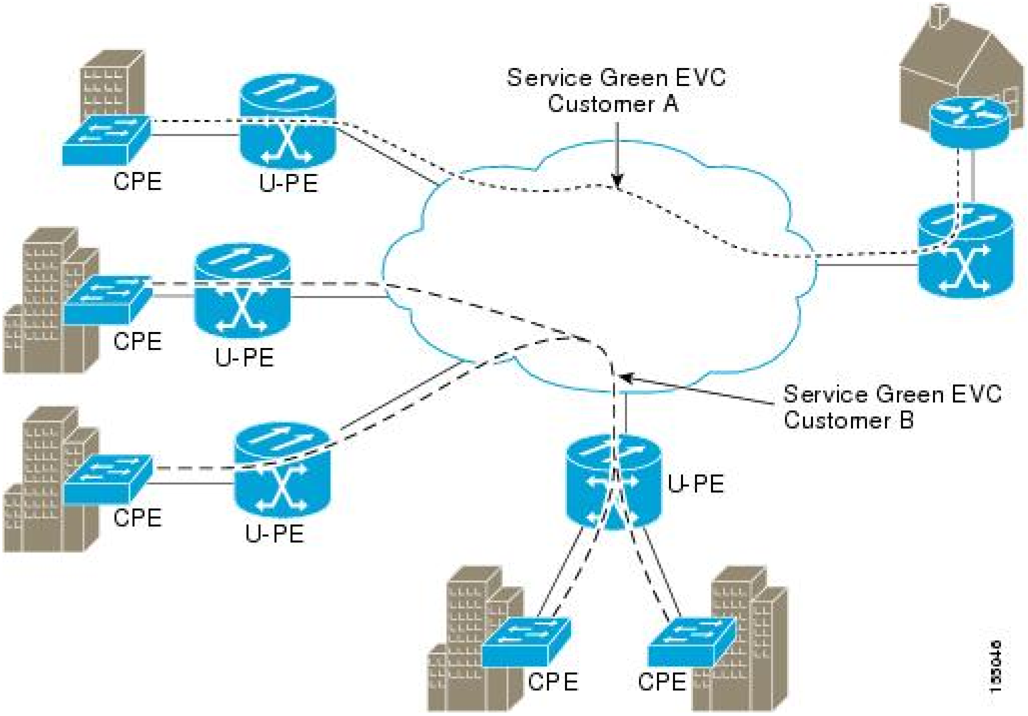
Benefits of Ethernet CFM

- End-to-end service-level OAM technology

- Reduced operating expense for service provider Ethernet networks
- Competitive advantage for service providers
- Supports both distribution and access network environments with the outward facing MEPs enhancement

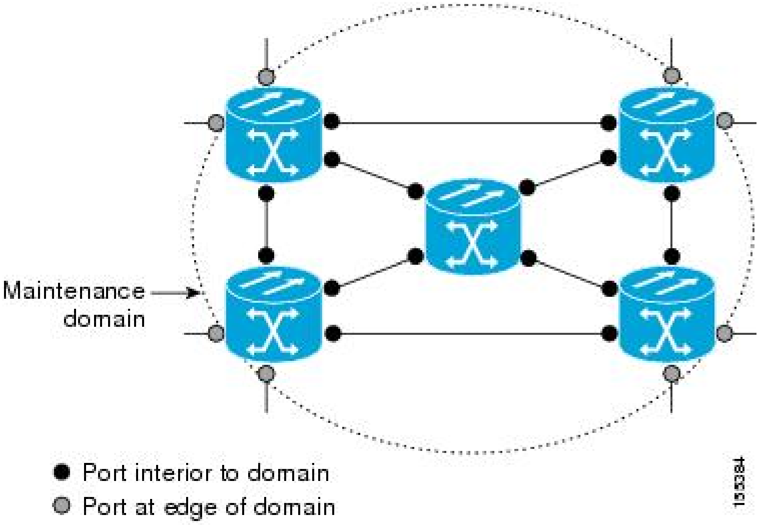
Customer Service Instance

A customer service instance is an Ethernet virtual connection (EVC), which is identified by an S-VLAN within an Ethernet island, and is identified by a globally unique service ID. A customer service instance can be point-to-point or multipoint-to-multipoint. The figure below shows two customer service instances. Service Instance Green is point to point; Service Instance Blue is multipoint to multipoint.



Maintenance Domain

A maintenance domain is 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 ports internal to it and at its boundary. The figure below illustrates a typical maintenance domain.

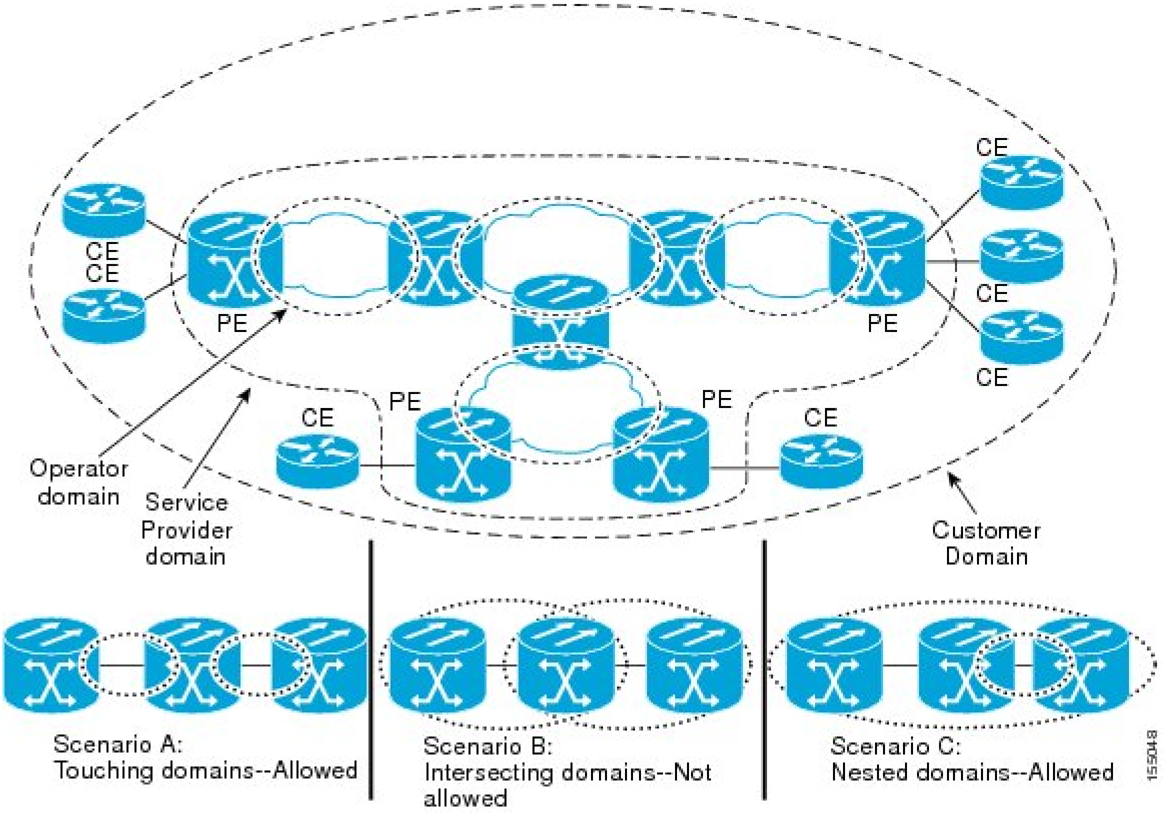


A unique maintenance level in the range of 0 to 7 is assigned to each domain by a network administrator. Levels and domain names are useful for defining the hierarchical relationship that exists among domains. The hierarchical relationship of domains parallels the structure of customer, service provider, and operator. The larger the domain, the higher the level value. For example, a customer domain would be larger than an operator domain. The customer domain may have a maintenance level of 7 and the operator domain may have a maintenance level of 0. Typically, operators would have the smallest domains and customers the largest domains, with service provider domains between them in size. All levels of the hierarchy must operate together.

Domains should not intersect because intersecting would mean management by more than one entity, which is not allowed. Domains may nest or touch but when two domains nest, the outer domain must have a higher maintenance level than the domain nested within it. Nesting maintenance domains is useful in the business model where a service provider contracts with one or more operators to provide Ethernet service to a customer. Each operator would have its own maintenance domain and the service provider would define its domain—a superset of the operator domains. Furthermore, the customer has its own end-to-end domain which is in turn a superset of the service provider domain. Maintenance levels of various nesting domains should be communicated among the administering organizations. For example, one approach would be to have the service provider assign maintenance levels to operators.

CFM exchanges messages and performs operations on a per-domain basis. For example, running CFM at the operator level does not allow discovery of the network by the higher provider and customer levels.

Network designers decide on domains and configurations. The figure below illustrates a hierarchy of operator, service provider, and customer domains and also illustrates touching, intersecting, and nested domains.


CE
CE
CE
CE
CE
PE
PE
PE
PE
CE
CE
Operator domain
Service Provider domain
Customer Domain
Scenario A: Touching domains--Allowed
Scenario B: Intersecting domains--Not allowed
Scenario C: Nested domains--Allowed
155048

Maintenance Associations and Maintenance Points

A maintenance association (MA) identifies a service that can be uniquely identified within the maintenance domain. The CFM protocol runs within a maintenance association. A maintenance point is a demarcation point on an interface that participates in CFM within a maintenance domain. Maintenance points drop all lower-level frames and forward all higher-level frames. There are two types of maintenance points:

- Maintenance end points (MEPs) are points at the edge of the domain that define the boundaries and confine CFM messages within these boundaries. Outward facing or Down MEPs communicate through the wire side (connected to the port). Inward facing or Up MEPs communicate through the relay function side, not the wire side.

  CFM 802.1ag supports up and down per-VLAN MEPs, as well as port MEPs, which are untagged down MEPs that are not associated with a VLAN.

  Port MEPs are configured to protect a single hop and used to monitor link state through CFM. If a port MEP is not receiving continuity check messages from its peer (static remote MEP), for a specified interval, the port is put into an operational down state in which only CFM and OAM packets pass through, and all other data and control packets are dropped.

  - **Up MEP**—An up MEP sends and receives CFM frames through the relay function. It drops all CFM frames at its level or lower that come from the wire side, except traffic going to the down MEP. For CFM frames from the relay side, it processes the frames at its level and drops frames at a lower level. The MEP transparently forwards all CFM frames at a higher level, regardless of whether they are received from the relay or wire side. If the port on which MEP is configured is blocked by STP, the MEP can still send or receive CFM messages through the relay function. CFM runs at the provider maintenance level (UPE-to-UPE), specifically with up MEPs at the user network interface (UNI).

Note The device rate-limits all incoming CFM messages at a fixed rate of 500 frames per second.

- **Dowm MEP**—A down MEP sends and receives CFM frames through the wire connected to the port on which the MEP is configured. It drops all CFM frames at its level or lower that come from the relay side. For CFM frames from the wire side, it processes all CFM frames at its level and drops CFM frames at lower levels except traffic going to the other lower-level down MEP. The MEP transparently forwards all CFM frames at a higher level, regardless of whether they are received from the relay or through the wire.

- Maintenance intermediate points (MIPs) are internal to a domain, not at the boundary, and respond to CFM only when triggered by traceroute and loopback messages. They forward CFM frames received from MEPs and other MIPs, drop all CFM frames at a lower level (unless MIP filtering is enabled), and forward all CFM frames at a higher level and at a lower level and regardless of whether they are received from the relay or wire side. When MIP filtering is enabled, the MIP drops CFM frames at a lower level. MIPs also catalog and forward continuity check messages (CCMs), but do not respond to them.

  MIP filtering is disabled by default, and you can configure it to be enabled or disabled. When MIP filtering is disabled, all CFM frames are forwarded.

  You can manually configure a MIP or configure the device to automatically create a MIP. You can configure a MEP without a MIP. In case of a configuration conflict, manually created MIPs take precedence over automatically created MIPs.

  If port on which the MEP is configured is blocked by Spanning-Tree Protocol (STP), the MIP can receive and might respond to CFM messages from both the wire and relay side, but cannot forward any CFM messages.

Maintenance Point

A maintenance point is a demarcation point on an interface (port) that participates in CFM within a maintenance domain. Maintenance points on device ports act as filters that confine CFM frames within the bounds of a domain by dropping frames that do not belong to the correct level. Maintenance points must be explicitly configured on Cisco devices. Two classes of maintenance points exist, MEPs and MIPs.

Maintenance Endpoints

Maintenance endpoints (MEPs) have the following characteristics:

- Per maintenance domain (level) and service (S-VLAN or EVC)
- At the edge of a domain, define the boundary
- Within the bounds of a maintenance domain, confine CFM messages
- When configured to do so, proactively transmit Connectivity Fault Management (CFM) continuity check messages (CCMs)
- At the request of an administrator, transmit traceroute and loopback messages

Inward Facing MEPs

Inward facing means the MEP communicates through the Bridge Relay function and uses the Bridge-Brain MAC address. An inward facing MEP performs the following functions:

- Sends and receives CFM frames at its level through the relay function, not via the wire connected to the port on which the MEP is configured.
- Drops all CFM frames at its level (or lower level) that come from the direction of the wire.
- Processes all CFM frames at its level coming from the direction of the relay function.
- Drops all CFM frames at a lower level coming from the direction of the relay function.
- Transparently forwards all CFM frames at its level (or a higher level), independent of whether they come in from the relay function side or the wire side.

Note A MEP of level L (where L is less than 7) requires a MIP of level M > L on the same port; hence, CFM frames at a level higher than the level of the MEP will be catalogued by this MIP.

- If the port on which the inward MEP is configured is blocked by Spanning-Tree Protocol, the MEP can no longer transmit or receive CFM messages.

Outward Facing MEPs for Port Channels

Outward facing means that the MEP communicates through the wire. Outward facing MEPs can be configured on port channels (using cross connect functionality). A MIP configuration at a level higher than the level of the outward facing MEP is not required.

Outward facing MEPs on port channels use the Bridge-Brain MAC address of the first member link. When port channel members change, the identities of outward facing MEPs do not have to change.

An outward facing MEP performs the following functions:

- Sends and receives CFM frames at its level via the wire connected to the port where the MEP is configured.
- Drops all CFM frames at its level (or at a lower level) that come from the direction of the relay function.
- Processes all CFM frames at its level coming from the direction of the wire.
- Drops all CFM frames at a lower level coming from the direction of the wire.
- Transparently forwards all CFM frames at levels higher than the level of the outward facing MEP, independent of whether they come in from the relay function side or the wire side.
- If the port on which the outward MEP is configured is blocked by the Spanning-Tree Protocol, the MEP can still transmit and receive CFM messages via the wire.

Maintenance Intermediate Points

MIPs have the following characteristics:

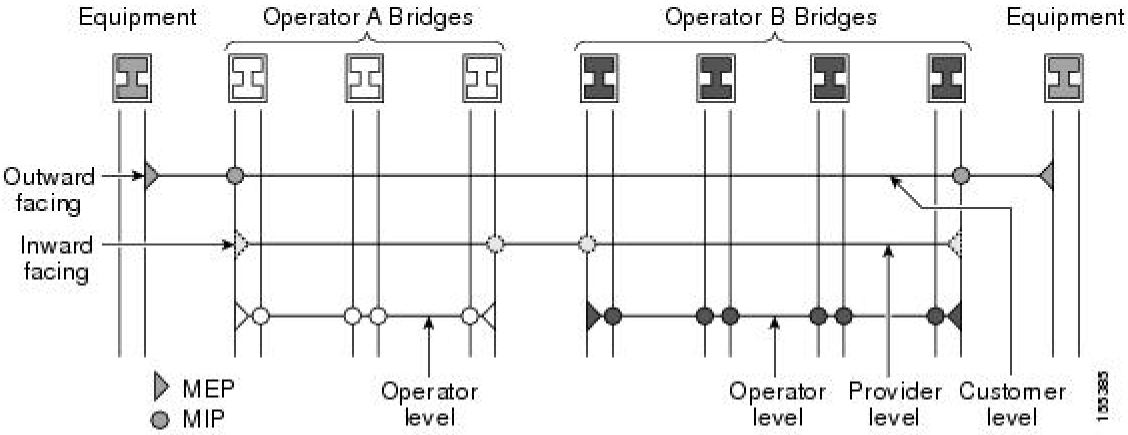
- Per maintenance domain (level) and for all S-VLANs enabled or allowed on a port.
- Internal to a domain, not at the boundary.

- CFM frames received from MEPs and other MIPs are cataloged and forwarded, using both the wire and the relay function.
- All CFM frames at a lower level are stopped and dropped, independent of whether they originate from the wire or relay function.
- All CFM frames at a higher level are forwarded, independent of whether they arrive from the wire or relay function.
- Passive points respond only when triggered by CFM traceroute and loopback messages.
- Bridge-Brain MAC addresses are used.

If the port on which a MIP is configured is blocked by Spanning-Tree Protocol, the MIP cannot receive CFM messages or relay them toward the relay function side. The MIP can, however, receive and respond to CFM messages from the wire.

A MIP has only one level associated with it and the command-line interface (CLI) does not allow you to configure a MIP for a domain that does not exist.

The figure below illustrates MEPs and MIPs at the operator, service provider, and customer levels.



CFM Messages

CFM uses standard Ethernet frames. CFM frames are distinguishable by EtherType and for multicast messages by MAC address. CFM frames are sourced, terminated, processed, and relayed by bridges. Routers can support only limited CFM functions.

Bridges that cannot interpret CFM messages forward them as normal data frames. All CFM messages are confined to a maintenance domain and to an S-VLAN (PE-VLAN or Provider-VLAN). Three types of messages are supported:

- Continuity Check
- Loopback
- Traceroute

Continuity Check Messages

CFM CCMs are multicast heartbeat messages exchanged periodically among MEPs. They allow MEPs to discover other MEPs within a domain and allow MIPs to discover MEPs. CCMs are confined to a domain and S-VLAN.

CFM CCMs have the following characteristics:

- Transmitted at a configurable periodic interval by MEPs. The interval can be from 10 seconds to 65535 seconds, the default is 30.
- Contain a configurable hold-time value to indicate to the receiver the validity of the message. The default is 2.5 times the transmit interval.
- Catalogued by MIPs at the same maintenance level.
- Terminated by remote MEPs at the same maintenance level.
- Unidirectional and do not solicit a response.
- Carry the status of the port on which the MEP is configured.

Loopback Messages

CFM loopback messages are unicast frames that a MEP transmits, at the request of an administrator, to verify connectivity to a particular maintenance point. A reply to a loopback message indicates whether a destination is reachable but does not allow hop-by-hop discovery of the path. A loopback message is similar in concept to an Internet Control Message Protocol (ICMP) Echo (ping) message.

A CFM loopback message can be generated on demand using the CLI. The source of a loopback message must be a MEP; the destination may be a MEP or a MIP. CFM loopback messages are unicast; replies to loopback messages also are unicast. CFM loopback messages specify the destination MAC address, VLAN, and maintenance domain.

Traceroute Messages

CFM traceroute messages are multicast frames that a MEP transmits, at the request of an administrator, to track the path (hop-by-hop) to a destination MEP. They allow the transmitting node to discover vital connectivity data about the path, and allow the discovery of all MIPs along the path that belong to the same maintenance domain. For each visible MIP, traceroute messages indicate ingress action, relay action, and egress action. Traceroute messages are similar in concept to User Datagram Protocol (UDP) traceroute messages.

Traceroute messages include the destination MAC address, VLAN, and maintenance domain and they have Time To Live (TTL) to limit propagation within the network. They can be generated on demand using the CLI. Traceroute messages are multicast; reply messages are unicast.

Cross-Check Function

The cross-check function is a timer-driven post-provisioning service verification between dynamically discovered MEPs (via CCMs) and expected MEPs (via configuration) for a service. The cross-check function verifies that all endpoints of a multipoint or point-to-point service are operational. The function supports notifications when the service is operational; otherwise it provides alarms and notifications for unexpected endpoints or missing endpoints.

The cross-check function is performed one time. You must initiate the cross-check function from the CLI every time you want a service verification.

Ethernet CFM and Ethernet OAM Interaction

To understand how CFM and OAM interact, you should understand the following concepts:

Ethernet Virtual Circuit

An EVC as defined by the Metro Ethernet Forum is a port-level point-to-point or multipoint-to-multipoint Layer 2 circuit. EVC status can be used by a CE device either to find an alternative path in to the service provider network or in some cases, to fall back to a backup path over Ethernet or over another alternative service such as ATM.

OAM Manager

The OAM manager is an infrastructure element that streamlines interaction between OAM protocols. The OAM manager requires two interworking OAM protocols, in this case Ethernet CFM and Ethernet OAM. Interaction is unidirectional from the OAM manager to the CFM protocol and the only information exchanged is the user network interface (UNI) port status. Additional port status values available include

- REMOTE_EE—Remote excessive errors
- LOCAL_EE—Local excessive errors
- TEST—Either remote or local loopback

After CFM receives the port status, it communicates that status across the CFM domain.

CFM over Bridge Domains

Connectivity Fault Management (CFM) over bridge domains allows untagged CFM packets to be associated with a maintenance end point (MEP). An incoming untagged customer CFM packet has an EtherType of CFM and is mapped to an Ethernet virtual circuit (EVC) or bridge domain based on the encapsulation configured on the Ethernet flow point (EFP). The EFP is configured specifically to recognize these untagged packets.

An EFP is a logical demarcation point of an EVC on an interface and can be associated with a bridge domain. The VLAN ID is used to match and map traffic to the EFP. VLAN IDs have local significance per port similar to an ATM virtual circuit. CFM is supported on a bridge domain associated with an EFP. The association between the bridge domain and the EFP allows CFM to use the encapsulation on the EFP. All EFPs in the same bridge domain form a broadcast domain. The bridge domain ID determines the broadcast domain.

The distinction between a VLAN port and the EFP is the encapsulation. VLAN ports use a default dot1q encapsulation. For EFPs, untagged, single tagged, and double tagged encapsulation exists with dot1q and IEEE dot1ad EtherTypes. Different EFPs belonging to the same bridge domain can use different encapsulations.

Both up MEP, down MEP and MIP are supported. If an up MEP is configured under an EFP within a bridge domain, CFM messages would be routed into the bridge, and the rest members of the same bridge domain would be able to receive messages from this MEP. If a down MEP is configured, the messages will not goes into the bridge domain.

How to Set Up Ethernet CFM in a Service Provider Network

Designing CFM Domains

Note To have an operator, service provider, or customer domain is optional. A network may have a single domain or multiple domains. The steps listed here show the sequence when all three types of domains will be assigned.

Before you begin

- Knowledge and understanding of the network topology.
- Understanding of organizational entities involved in managing the network; for example, operators, service providers, network operations centers (NOCs), and customer service centers.
- Understanding of the type and scale of services to be offered.
- Agreement by all organizational entities on the responsibilities, roles, and restrictions for each organizational entity.
- Determination of the number of maintenance domains in the network.
- Determination of the nesting and disjoint maintenance domains.
- Assignment of maintenance levels and names to domains based on agreement between the service provider and operator or operators.
- Determination of whether the domain should be inward or outward.

SUMMARY STEPS

1. Determine operator level MIPs.
2. Determine operator level MEPs.
3. Determine service provider MIPs.
4. Determine service provider MEPs.
5. Determine customer MIPs.
6. Determine customer MEPs.

DETAILED STEPS

	Command or Action	Purpose
Step 1	Determine operator level MIPs.	Follow these steps: • Starting at lowest operator level domain, assign a MIP at every interface internal to the operator network to be visible to CFM. • Proceed to next higher operator level and assign MIPs.

	Command or Action	Purpose
		• Verify that every port that has a MIP at a lower level does not have maintenance points at a higher level. • Repeat steps a through d until all operator MIPs are determined.
Step 2	Determine operator level MEPs.	Follow these steps: • Starting at the lowest operator level domain, assign a MEP at every UNI that is part of a service instance. • Assign a MEP at the network to network interface (NNI) between operators, if there is more than one operator. • Proceed to next higher operator level and assign MEPs. • A port with a MIP at a lower level cannot have maintenance points at a higher level. A port with a MEP at a lower level should have either a MIP or MEP at a higher level.
Step 3	Determine service provider MIPs.	Follow these steps: • Starting at the lowest service provider level domain, assign service provider MIPs at the NNI between operators (if more than one). • Proceed to next higher service provider level and assign MIPs. • A port with a MIP at a lower level cannot have maintenance points at a higher level. A port with a MEP at a lower level should not have either a MIP or a MEP at a higher level.
Step 4	Determine service provider MEPs.	Follow these steps: • Starting at the lowest service provider level domain, assign a MEP at every UNI that is part of a service instance. • Proceed to next higher service provider level and assign MEPs. • A port with a MIP at a lower level cannot have maintenance points at a higher level. A port with a MEP at a lower level should have either a MIP or a MEP at a higher level.
Step 5	Determine customer MIPs.	Customer MIPs are allowed only on the UNIs at the uPEs if the service provider allows the customer to run CFM.

	Command or Action	Purpose
		Otherwise, the service provider can configure Cisco devices to block CFM frames. • Configure a MIP on every uPE, at the UNI port, in the customer maintenance domain. • Ensure the MIPs are at a maintenance level that is at least one higher than the highest level service provider domain.
Step 6	Determine customer MEPs.	Customer MEPs are on customer equipment. Assign an outward facing MEP within an outward domain at the appropriate customer level at the handoff between the service provider and the customer.

Configuring Ethernet CFM

Configuring Ethernet CFM consists of the following tasks:

Configuring CFM

This task explains minimal basic configuration for CFM.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **ethernet cfm domain** *domain-name* **level** *level-id*
4. **service** *short-ma-name* **evc** *evc-name* **vlan** *vlanid* **direction down**
5. **continuity-check**
6. **continuity-check** [**interval** *cc-interval*]
7. **exit**
8. **mep archive-hold-time** *minutes*
9. **exit**
10. **ethernet cfm global**
11. **etheret cfm ieee**
12. **ethernet cfm traceroute cache**
13. **ethernet cfm traceroute cache size** *entries*
14. **ethernet cfm traceroute cache hold-time** *minutes*
15. **snmp-server enable traps ethernet cfm cc** [**mep-up**] [**mep-down**] [**config**] [**loop**] [**cross-connect**]
16. **snmp-server enable traps ethernet cfm crosscheck** [**mep-unknown** | **mep-missing** | **service-up**]
17. **end**
18. **interface** *type number*
19. **service instance** *id* **ethernet** [*evc-name*]
20. **encapsulation** *encapsulation-type*
21. **bridge-domain** *bridge-id*

22. **cfm mep domain** *domain-name* **mpid** *id*
23. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**ethernet cfm domain** *domain-name* **level** *level-id* **Example:** `Device(config)# ethernet cfm domain Customer level 7`	Defines a CFM maintenance domain at a particular maintenance level and enters Ethernet CFM configuration mode.
Step 4	**service** *short-ma-name* **evc** *evc-name* **vlan** *vlanid* **direction down** **Example:** `Device(config-ecfm)# service s41 evc 41 vlan 41 direction down`	Configures a maintenance association within a maintenance domain and enters Ethernet connectivity fault management (CFM) service configuration mode. **Note** The **direction down** is used only for Down or Outward-facing MEPs. For Up MEPs or Inward-facing MEPs, do not specify **direction down**. **Note** To configure MA CFM service for EoMPLS, use **service** *shoet-ma-name* **evc** *evc-name*.
Step 5	**continuity-check** **Example:** `Device(config-ecfm-srv)# continuity-check`	Enables the transmission of continuity check messages (CCMs).
Step 6	**continuity-check** [**interval** *cc-interval*] **Example:** `Device(config-ecfm-srv)# continuity-check interval 10s`	Configures the time period between CCMs transmission. The default interval is 10 seconds.
Step 7	**exit** **Example:** `Device(config-ecfm-srv)# exit`	Returns to Ethernet connectivity fault management configuration mode.
Step 8	**mep archive-hold-time** *minutes* **Example:** `Device(config-ecfm)# mep archive-hold-time 60`	Sets the amount of time that data from a missing MEP is kept in the continuity check database or that entries are held in the error database before they are purged.

	Command or Action	Purpose
Step 9	**exit** **Example:** `Device(config-ecfm)# exit`	Returns to global configuration mode.
Step 10	**ethernet cfm global** **Example:** `Device(config)# ethernet cfm global`	Enables CFM processing globally on the device.
Step 11	**etheret cfm ieee** **Example:** `Router(config)# ethernef cfm ieee`	Enables CFM IEEE version of CFM. This command is automatically issued when the ethernet cfm global command is issued.
Step 12	**ethernet cfm traceroute cache** **Example:** `Device(config)# ethernet cfm traceroute cache`	Enables caching of CFM data learned through traceroute messages.
Step 13	**ethernet cfm traceroute cache size** *entries* **Example:** `Device(config)# ethernet cfm traceroute cache size 200`	Sets the maximum size for the CFM traceroute cache table.
Step 14	**ethernet cfm traceroute cache hold-time** *minutes* **Example:** `Device(config)# ethernet cfm traceroute cache hold-time 60`	Sets the amount of time that CFM traceroute cache entries are retained.
Step 15	**snmp-server enable traps ethernet cfm cc** [**mep-up**] [**mep-down**] [**config**] [**loop**] [**cross-connect**] **Example:** `Device(config)# snmp-server enable traps ethernet cfm cc mep-up mep-down config loop cross-connect`	Enables SNMP trap generation for Ethernet CFM continuity check events.
Step 16	**snmp-server enable traps ethernet cfm crosscheck** [**mep-unknown** | **mep-missing** | **service-up**] **Example:** `Device(config)# snmp-server enable traps ethernet cfm crosscheck mep-unknown mep-missing service-up`	Enables SNMP trap generation for Ethernet CFM continuity check events in relation to the cross-check operation between statically configured MEPS and those learned via CCMs.

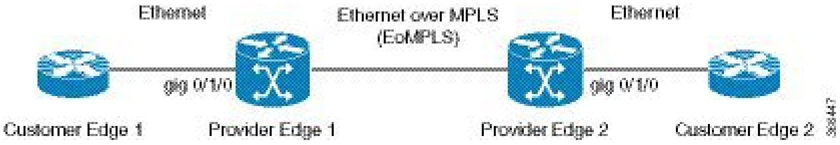
Step 17	**end**
	Example:
	`Device(config)# end`
		Returns to privileged EXEC mode.

	Command or Action	Purpose
Step 18	**interface** *type number* **Example:** `Device(config)# interface gigabitethernet0/0/1`	Specifies an interface and enters interface configuration mode.
Step 19	**service instance** *id* **ethernet** [*evc-name*] **Example:** `Device(config-if)# service instance 333 ethernet evc1`	Configures an Ethernet service instance on an interface and enters Ethernet service configuration mode.
Step 20	**encapsulation** *encapsulation-type* **Example:** `Device(config-if-srv)# encapsulation dot1q 5`	Sets the encapsulation method used by the interface.
Step 21	**bridge-domain** *bridge-id* **Example:** `Device(config-if-srv)# bridge-domain 100`	Binds a service instance to a bridge domain instance.
Step 22	**cfm mep domain** *domain-name* **mpid** *id* **Example:** `Device(config-if-srv)# cfm mep domain L4 mpid 4001`	Configures the MEP domain and the ID.

Step 23	**end**
	Example:
	`Device(config-if-srv)# end`
		Returns to privileged EXEC mode.

Example: Configuring CFM

The below example explains CFM configuration over Layer2 VPN (EoMPLS) network.



Example For Configuring CFM over EoMPLS

Note Ensure that EoMPLS configuration are UP and running before configuring CFM.

PE1 Configuration

```
ethernet cfm ieee
ethernet cfm global                    ! enable CFM on the router
ethernet cfm domain PE1-2 level 6      ! define domain PE1-2
 17

service EVC-PE-200 evc evc-200
```

```
  continuity-check
  continuity-check interval 1s
!

ethernet cfm logging
ethernet evc evc-200
!
interface GigabitEthernet0/1 /0
no ip address
negotiation auto
   service instance 200 ethernet evc-200
     encapsulation dot1q 200-300
     cfm mep domain PE1-2 mpid 1200                ! created MEP

exit
interface pseudowire 200
 encapsualtion mpls
 neighbor 10.10.4.4
!
l2vpn xconnect context PW200
 member GigabitEthernet0/1/0 service-instance 200
 member 10.10.4.4 200 encapsulation mpls
```

PE2 Configuration

```
ethernet cfm ieee
ethernet cfm global         ! enable CFM on the router
ethernet cfm domain PE1-2 level 6
service EVC-PE-200 evc evc-200
 continuity-check
 continuity-check interval 1s

!
ethernet cfm logging
ethernet evc evc-200
!
interface GigabitEthernet0/1/0
  no ip address
  negotiation auto
  service instance 200 ethernet evc -200
    encapsulation dot1q 200-300
    cfm mep domain PE1-2 mpid 1201   ! mpid must be different from remote end


!
interface pseudowire200
  encapsulation mpls
  neighbor 10.10.3.3 200


!
l2vpn xconnect context PW200
member gigabitethernet0/1/0
service-instance 200 pseudowire200
```

Example for Verifying CFM

show ethernet cfm maintenance-points local

```
Router# show ethernet cfm maintenance-points local
Local MEPs:
--------------------------------------------------------------------------------
MPID Domain Name                                 Lvl   MacAddress     Type CC
```

```
Ofld Domain Id                                   Dir   Port          Id
MA Name                                                SrvcInst      Source
EVC name
----------------------------------------------------------------------------------


1201 PE1-2                                        6     7010.5c51.a4bf XCON Y
No  PE1-2                                         Up    Gi0/1/0       N/A
EVC-PE-200                                              200           Static
evc-200
Total Local MEPs: 1
```

show ethernet cfm maintenance-points remote

```
ASR903-PE2# show ethernet cfm maintenance-points remote
--------------------------------------------------------------------------------
MPID  Domain Name                                 MacAddress          IfSt PtSt
Lvl   Domain ID                                   Ingress
RDI   MA Name                                     Type Id             SrvcInst
      EVC Name                                                        Age
      Local MEP Info
--------------------------------------------------------------------------------
1200  PE1-2                                      7010.5c51.8fbf       Up    Up
6    PE1-2                                       Gi0/1/0:(10.10.3.3, 200)
-    EVC-PE-200                                  XCON N/A            200
     evc-200                                                         0s
     MPID: 1201 Domain: PE1-2 MA: EVC-PE-200
Total Remote MEPs: 1
```

CFM Use Cases

Example For Configuring CFM over Bridge Domain

```
ethernet cfm ieee
ethernet cfm global
ethernet cfm domain cust1 level 7
  service s1 evc 1 vlan 1
   continuity-check
   continuity-check interval 3.3ms

service instance 1 ethernet 1
  encapsulation dot1q 1
  bridge-domain 1
  cfm mep domain cust1 mpid 1
```

Example For Configuring CFM over Trunk EFP

Note For trunk EFP, MEP is configured under the interface level configuration.

```
ethernet cfm domain oper2 level 7
service strunk evc 1000 vlan 800 direction down
  continuity-check
  continuity-check interval 3.3ms

ethernet cfm mep domain oper2 mpid 8191 service strunk --- this creates MEP
service instance trunk 1000 ethernet
  encapsulation dot1q 500-1000
  rewrite ingress tag pop 1 symmetric
  bridge-domain from-encapsulation
```

Example For Configuring CFM over VPLS

Note The EVC name used should be similar to the EVC configured in CFM configuration.

CFM over VPLS: Using the **legacy l2 vfi** command

```
ethernet cfm ieee
ethernet cfm global
ethernet cfm domain dom01 level 5

service serv01 evc evc26 vlan 26
  continuity-check
  continuity-check interval 3.3ms

service instance 26 ethernet evc26
  encapsulation dot1q 26
  rewrite ingress tag pop 1 symmetric
  bridge-domain 26
  cfm mep domain dom01 mpid 1

l2 vfi test manual evc26 ===== The evc name should be same as configuredin CFM config
vpn id 26
bridge-domain 26
neighbor 2.2.2.2 encapsulation mpls
```

CFM over VPLS: Using l2vpn vfi context command

```
ethernet cfm ieee
ethernet cfm global
ethernet cfm domain dom01 level 5
service serv01 evc evc26 vlan 26
  continuity-check
  continuity-check interval 3.3ms
l2vpn vfi context vpls26
  vpn id 26
  evc evc26
  member 2.2.2.2 encapsulation mpls
  member 1.1.1.1 encapsulation mpls
Int gi0/0/1
Service instance 26 ethernet evc26
Encapsulation dot1q 26
cfm mep domain dom01 mpid 1

bridge-domain 26
  member GigabitEthernet0/0/1 service-instance 26
  member vfi vpls26
```

Note The EVC name used should be similar to the EVC configured in CFM configuration.

Example For Configuring CFM over Default Encapsulation

```
ethernet cfm domain oper2 level 7
service cust1 evc 1000 vlan 1500 direction down
  continuity-check
  continuity-check interval 3.3ms

service instance 1000 ethernet 1000
```

```
  encapsulation default
  bridge-domain 1500
  cfm mep domain cust1 mpid 8191
  cfm encapsulation dot1q 1500
```

Verification Commands for CFM

Use the following commands to verify CFM:

- **show ethernet cfm maintenance-points local**
- **show ethernet cfm maintenance-points remote**
- **show ethernet cfm statistics**
- **show ethernet cfm ccm-learning-database**
- **show ethernet cfm errors**

SNMP Traps

The support provided by the Cisco IOS XE software implementation of Ethernet CFM traps is Cisco proprietary information. MEPs generate two types of Simple Network Management Protocol (SNMP) traps, continuity check (CC) traps and cross-check traps.

CC Traps

- MEP up--Sent when a new MEP is discovered, the status of a remote port changes, or connectivity from a previously discovered MEP is restored after interruption.
- MEP down--Sent when a timeout or last gasp event occurs.
- Cross-connect--Sent when a service ID does not match the VLAN.
- Loop--Sent when a MEP receives its own CCMs.
- Configuration error--Sent when a MEP receives a continuity check with an overlapping MPID.

Cross-Check Traps

- Service up--Sent when all expected remote MEPs are up in time.
- MEP missing--Sent when an expected MEP is down.
- Unknown MEP--Sent when a CCM is received from an unexpected MEP.

Steps to Generate SNMP Traps for CFM

To generate SNMP traps, following commands need to be configured on the router.

```
ethernet cfm logging
logging snmp-trap 0 7
logging history debugging
```

Note If syslog trap is enabled, by default trap is generated for messages of severity level emergency, alert, critical, error and warning (0-4). For other severity levels need to enable **logging snmp-trap 0 7** and **logging history debugging**

```
Router(config)#ethernet cfm logging
Router(config)#logging snmp-trap 0 7
Router(config)#logging history debugging
Router(config)#
```

Logs for MEP going DOWN

```
Console-logs:

Router(config)#
*Oct 26 21:32:06.663 IST: %E_CFM-3-REMOTE_MEP_DOWN: Remote MEP mpid 10 evc 2 vlan 2 MA name
 s2 in domain cust2 changed state to down with event code TimeOut.
*Oct 26 21:32:06.664 IST: %E_CFM-6-ENTER_AIS: local mep with mpid 20 level 2 BD/VLAN 2 dir
 D Interface Te0/3/1 enters AIS defect condition
*Oct 26 21:32:09.147 IST: %E_CFM-3-FAULT_ALARM: A fault has occurred in the network for the
 local MEP having mpid 20 evc 2 vlan 2 for service MA name s2 with the event code
DefRemoteCCM.
```

SNMP Server Side Logs

Received SNMPv2c Trap

```
Community: public
From: 7.32.22.154
sysUpTimeInstance = 04:00:54.27
snmpTrapOID.0 = clogMessageGenerated
clogHistFacility.76 = E_CFM
clogHistSeverity.76 = error(4)
clogHistMsgName.76 = REMOTE_MEP_DOWN
clogHistMsgText.76 = Remote MEP mpid 10 evc 2 vlan 2 MA name s2 in domain cust2 changed
state to down with event code TimeOut.
clogHistTimestamp.76 = 04:00:54.27
```

Received SNMPv2c Trap

```
Community: public
From: 7.32.22.154
sysUpTimeInstance = 04:00:54.27
snmpTrapOID.0 = clogMessageGenerated
clogHistFacility.77 = E_CFM
clogHistSeverity.77 = info(7)
clogHistMsgName.77 = ENTER_AIS
clogHistMsgText.77 = local mep with mpid 20 level 2 BD/VLAN 2 dir D Interface Te0/3/1 enters
 AIS defect condition
clogHistTimestamp.77 = 04:00:54.27
```

Received SNMPv2c Trap

```
Community: public
From: 7.32.22.154
sysUpTimeInstance = 04:00:56.75
snmpTrapOID.0 = dot1agCfmFaultAlarm
dot1agCfmMepHighestPrDefect.10.2.20 = defRemoteCCM(3)
```

Received SNMPv2c Trap

```
Community: public
From: 7.32.22.154
sysUpTimeInstance = 04:00:56.75
snmpTrapOID.0 = clogMessageGenerated
clogHistFacility.78 = E_CFM
clogHistSeverity.78 = error(4)
clogHistMsgName.78 = FAULT_ALARM
clogHistMsgText.78 = A fault has occurred in the network for the local MEP having mpid 20
evc 2 vlan 2 for service MA name s2 with the event code DefRemoteCCM.
clogHistTimestamp.78 = 04:00:56.75
```

Logs for MEP Coming Up

Console-logs

```
===============================================
Router(config)#
*Oct 26 21:35:03.780 IST: %E_CFM-6-REMOTE_MEP_UP: Continuity Check message is received from
 a remote MEP with mpid 10 evc 2 vlan 2 MA name s2 domain cust2 interface status Up event
code Returning.
*Oct 26 21:35:03.781 IST: %E_CFM-6-EXIT_AIS: local mep with mpid 20 level 2 BD/VLAN 2 dir
D Interface Te0/3/1 exited AIS defect condition
```

SNMP Server Side Logs

Received SNMPv2c Trap

```
===============================================
Community: public
From: 7.32.22.154
sysUpTimeInstance = 04:03:51.39
snmpTrapOID.0 = clogMessageGenerated
clogHistFacility.79 = E_CFM
clogHistSeverity.79 = info(7)
clogHistMsgName.79 = REMOTE_MEP_UP
clogHistMsgText.79 = Continuity Check message is received from a remote MEP with mpid 10
evc 2 vlan 2 MA name s2 domain cust2 interface status Up event code Returning.
clogHistTimestamp.79 = 04:03:51.38
```

Received SNMPv2c Trap

```
Community: public
From: 7.32.22.154
sysUpTimeInstance = 04:03:51.39
snmpTrapOID.0 = clogMessageGenerated
```

```
clogHistFacility.80 = E_CFM
clogHistSeverity.80 = info(7)
clogHistMsgName.80 = EXIT_AIS
clogHistMsgText.80 = local mep with mpid 20 level 2 BD/VLAN 2 dir D Interface Te0/3/1 exited
 AIS defect condition
clogHistTimestamp.80 = 04:03:51.38
```

Configuring and Enabling Cross-Checking for MEP

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **mep crosscheck mpid** *id* **vlan** *vlan-id* [**mac** *mac-address*]
4. **ethernet cfm mep crosscheck start-delay** *delay*
5. **ethernet cfm mep crosscheck** {**enable** | **disable**} **level** {*level-id* | *level-id-level-id* [,*level-id-level-id*]} **vlan** {*vlan-id* | **any** | *vlan-id-vlan-id* [,*vlan-id-vlan-id*]}

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**mep crosscheck mpid** *id* **vlan** *vlan-id* [**mac** *mac-address*] **Example:** `Device(config-ether-cfm)# mep crosscheck mpid 402 vlan 100`	Statically defines a remote MEP on a specified VLAN within the domain.
Step 4	**ethernet cfm mep crosscheck start-delay** *delay* **Example:** `Device(config)# ethernet cfm mep crosscheck start-delay 60`	Configures the maximum amount of time that the device waits for remote MEPs to come up before the cross-check operation is started
Step 5	**ethernet cfm mep crosscheck** {**enable** | **disable**} **level** {*level-id* | *level-id-level-id* [,*level-id-level-id*]} **vlan** {*vlan-id* | **any** | *vlan-id-vlan-id* [,*vlan-id-vlan-id*]} **Example:** `Device# ethernet cfm mep crosscheck enable level 4 vlan 100`	Enables cross-checking between remote MEPs in the domain and MEPs learned through CCMs.

Configuring Cross-checking on MEP

```
Router(config)# ethernet cfm domain ServiceProvider level 4
ethernet cfm domain ServiceProvider level 4
mep crosscheck mpid 402 vlan 100
!
ethernet cfm mep crosscheck start-delay 60
```

Troubleshooting Tips

To verify and isolate a fault, start at the highest level maintenance domain and do the following:

- Check the device error status.
- When an error exists, perform a loopback test to confirm the error.
- Run a traceroute to the destination to isolate the fault.
- If the fault is identified, correct the fault.
- If the fault is not identified, go to the next lower maintenance domain and repeat these four steps at that maintenance domain level.
- Repeat the first four steps, as needed, to identify and correct the fault.

Additional References for Configuring Ethernet Connectivity Fault Management in a Service Provider Network

Related Documents

Related Topic	Document Title
Carrier Ethernet commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	Cisco IOS Carrier Ethernet Command Reference
Cisco IOS commands: master list of commands with complete command syntax, command mode, command history, defaults, usage guidelines, and examples	Cisco IOS Master Command List, All Releases
IEEE 802.3ah	*IEEE 802.3ah Ethernet in the First Mile*
ISSU feature and functions	*High Availability Configuration Guide*
SSO	*High Availability Configuration Guide*
Configuring CFM over an EFP Interface with the Cross Connect feature on the Cisco ASR 903 Router.	*Configuring the CFM over EFP Interface with Cross Connect Feature*
Configuring Ethernet Virtual Connections on the Cisco ASR 903 Router	*Configuring Ethernet Virtual Connections on the Cisco ASR 903 Router*

Standards

Standard	Title
IEEE P802.1ag/D1.0	*Standard for Local and Metropolitan Area Networks - Virtual Bridged Local Area Networks - Amendment 5: Connectivity Fault Management*
IETF VPLS OAM	*L2VPN OAM Requirements and Framework*
ITU-T	*ITU-T Y.1731 OAM Mechanisms for Ethernet-Based Networks*

MIBs

MIB	MIBs Link
CISCO-ETHER-CFM-MIB	To locate and download MIBs for selected platforms, Cisco software releases, and feature sets, use Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Glossary

CCM—continuity check message. A multicast CFM frame that a MEP transmits periodically to ensure continuity across the maintenance entities to which the transmitting MEP belongs, at the MA level on which the CCM is sent. No reply is sent in response to receiving a CCM.

EVC—Ethernet virtual connection. An association of two or more user-network interfaces.

fault alarm—An out-of-band signal, typically an SNMP notification, that notifies a system administrator of a connectivity failure.

inward-facing MEP—A MEP that resides in a bridge and transmits to and receives CFM messages from the direction of the bridge relay entity.

maintenance domain—The network or part of the network belonging to a single administration for which faults in connectivity are to be managed. The boundary of a maintenance domain is defined by a set of DSAPs, each of which may become a point of connectivity to a service instance.

maintenance domain name—The unique identifier of a domain that CFM is to protect against accidental concatenation of service instances.

MEP—maintenance endpoint. An actively managed CFM entity associated with a specific DSAP of a service instance, which can generate and receive CFM frames and track any responses. It is an endpoint of a single MA, and terminates a separate maintenance entity for each of the other MEPs in the same MA.

MEP CCDB—A database, maintained by every MEP, that maintains received information about other MEPs in the maintenance domain.

MIP—maintenance intermediate point. A CFM entity, associated with a specific pair of ISS SAPs or EISS Service Access Points, which reacts and responds to CFM frames. It is associated with a single maintenance association and is an intermediate point within one or more maintenance entities.

MIP CCDB—A database of information about the MEPs in the maintenance domain. The MIP CCDB can be maintained by a MIP.

MP—maintenance point. Either a MEP or a MIP.

MPID—maintenance endpoint identifier. A small integer, unique over a given MA, that identifies a specific MEP.

OAM—operations, administration, and maintenance. A term used by several standards bodies to describe protocols and procedures for operating, administrating, and maintaining networks. Examples are ATM OAM and IEEE Std. 802.3ah OAM.

operator—Entity that provides a service provider a single network of provider bridges or a single Layer 2 or Layer 3 backbone network. An operator may be identical to or a part of the same organization as the service provider. For purposes of IEEE P802.1ag, Draft Standard for Local and Metropolitan Area Networks, the operator and service provider are presumed to be separate organizations.

Terms such as “customer,” “service provider,” and “operator” reflect common business relationships among organizations and individuals that use equipment implemented in accordance with IEEE P802.1ag.

UNI—user-network interface. A common term for the connection point between an operator's bridge and customer equipment. A UNI often includes a C-VLAN-aware bridge component. The term UNI is used broadly in the IEEE P802.1ag standard when the purpose for various features of CFM are explained. UNI has no normative meaning.