Configuring Ethernet OAM on Cisco IOS XR Software

This module describes the configuration of Ethernet Operations, Administration, and Maintenance (OAM) on the Cisco XR 12000 Series Router.

Feature History for Configuring Ethernet OAM

Release	Modification
Release 4.0.0	Support for the following features was introduced: • Ethernet CFM on AToM core • Ethernet Link OAM
Release 4.1.0	Support for the following features was introduced: • AIS • CFM Y.1731 ITU Carrier Code (ICC)-based MEG ID (MAID) format. • EFD • Ethernet CFM on Layer 2 Tunneling Protocol Version 3 (L2TPv3) core. Up MEPs and MIPs are now supported on Virtual Private Wire Service (VPWS) cross-connects over L2TPv3. • Ethernet SLA

Contents

Prerequisites for Configuring Ethernet OAM

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 Ethernet OAM, confirm that at least one of the Gigabit Ethernet line cards supported on the router is installed:

- 8-Port Fast Ethernet SPA
- 2-Port Gigabit Ethernet SPA
- 5-Port Gigabit Ethernet SPA
- 8-Port Gigabit Ethernet SPA
- 10-Port Gigabit Ethernet SPA
- 1-Port 10-Gigabit Ethernet SPA

Restrictions for Configuring Ethernet OAM

The following functional areas of Ethernet OAM are not supported on the Cisco XR 12000 Series Router in Cisco IOS XR Release 4.1:

- Remote Loopback
- Symbol period thresholds and window for link monitoring
- Unidirectional link-fault detection

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, and take actions on 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 EOAM 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.

The following standard Ethernet Link OAM features are supported on the router:

Neighbor Discovery

Neighbor discovery enables each end of a link to learn the OAM capabilities of the other end and establish an OAM peer relationship. Each end also can require that the peer have certain capabilities before it will establish a session. You can configure certain actions to be taken if there is a capabilities conflict or if a discovery process times out, using the **action capabilities-conflict** or **action discovery-timeout** commands.

Link Monitoring

Link monitoring enables an OAM peer to monitor faults that cause the quality of a link to deteriorate over time. When link monitoring is enabled, an OAM peer can be configured to take action when the configured thresholds are exceeded.

MIB Retrieval

MIB retrieval enables an OAM peer on one side of an interface to get the MIB variables from the remote side of the link. The MIB variables that are retrieved from the remote OAM peer are READ ONLY.

Miswiring Detection (Cisco-Proprietary)

Miswiring Detection is a Cisco-proprietary feature that uses the 32-bit vendor field in every Information OAMPDU to identify potential miswiring cases.

SNMP Traps

SNMP traps can be enabled or disabled on an Ethernet OAM interface.

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 on the Cisco XR 12000 Series Router supports the following 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.

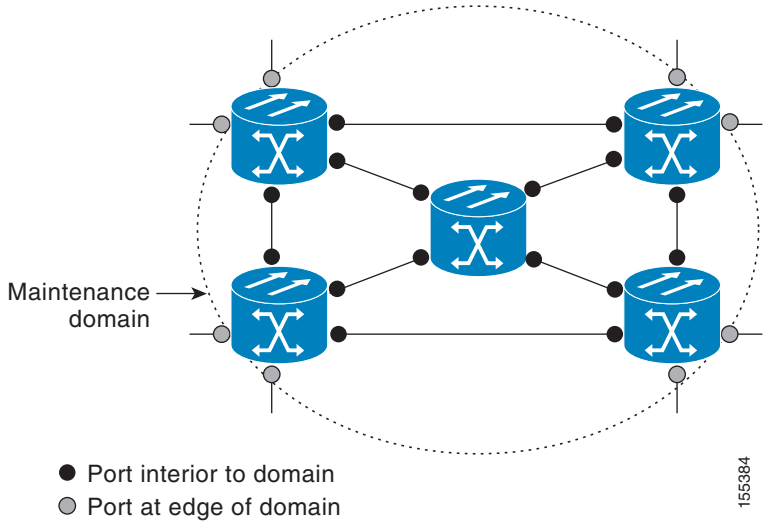
- ETH-AIS—The reception of ETH-LCK messages is also supported.
- ETH-DM—This is supported with the Ethernet SLA feature. For more information about Ethernet SLA, see the "Ethernet SLA (Y.1731 Performance Monitoring)" section on page 135.

To understand how the CFM maintenance model works, you need to understand the following 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 Figure 1.

Figure 1 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.

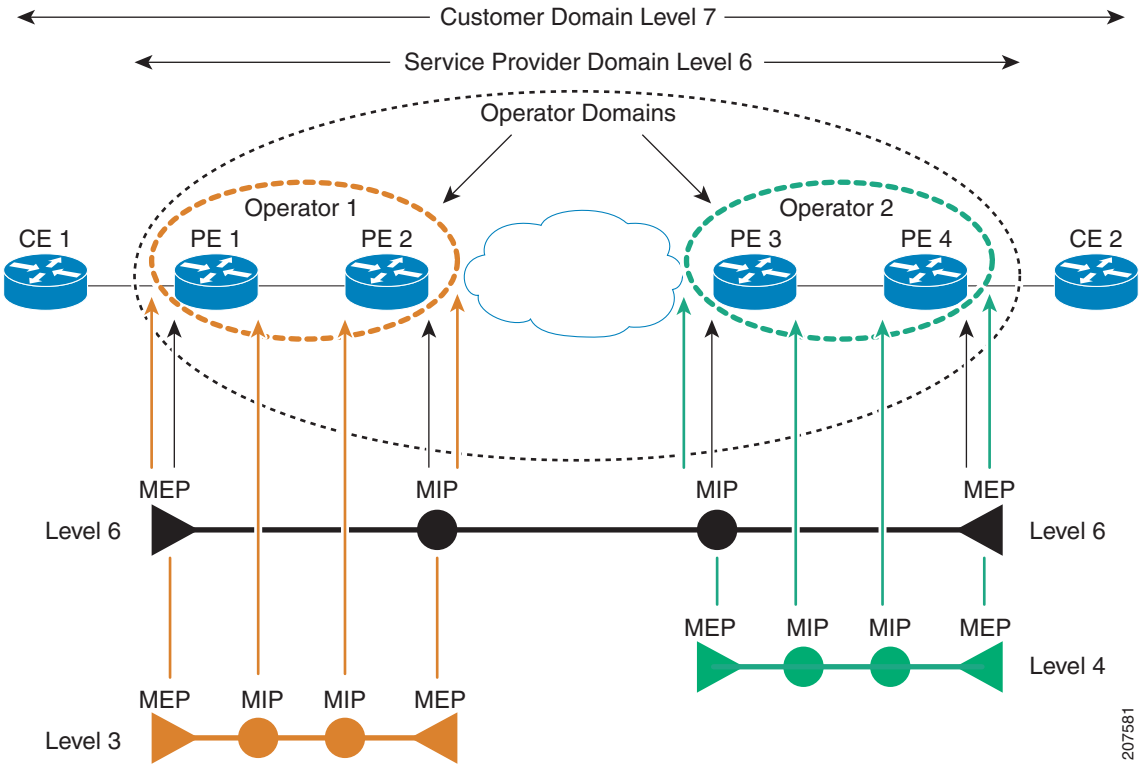
- Each operator can use CFM within their operator network, to verify and manage connectivity within their network.

Each organization uses a different CFM maintenance domain.

Figure 2 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 123.

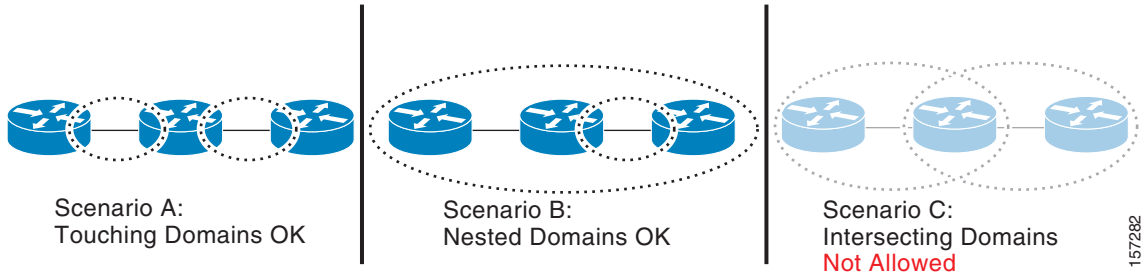
Figure 2 Different CFM Maintenance Domains Across a Network



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. Figure 3 illustrates the supported structure for touching and nested domains, and the unsupported intersection of domains.

Figure 3 Supported CFM Maintenance Domain Structure



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 in the higher or lower maintenance levels are forwarded transparently. This helps enforce the maintenance domain hierarchy described in the "Maintenance Domains" section on page 121, 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. MIPs allow CFM frames to be forwarded at either lower, higher, or their own maintenance levels.

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 cross-connect for the interface is found, and all services associated with that 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.

Figure 4 illustrates the monitored areas for Down and Up MEPs.

Figure 4 Monitored Areas for Down and Up MEPs

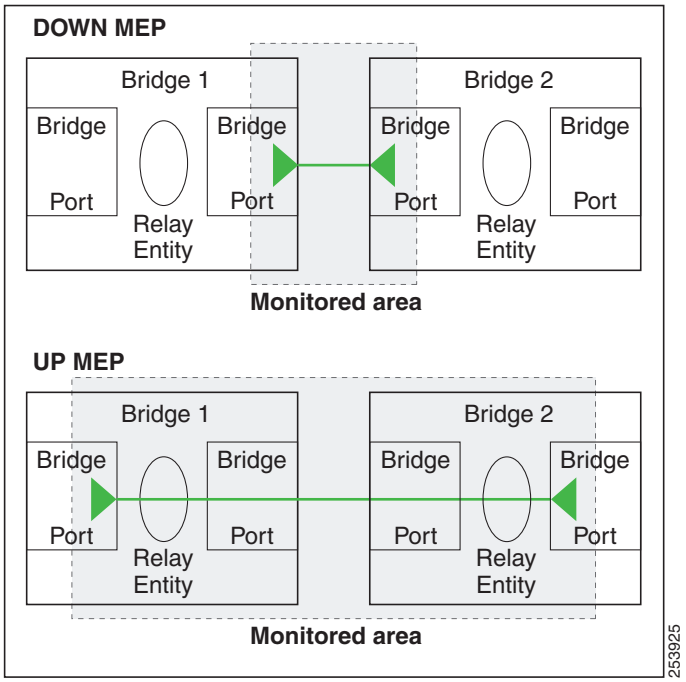
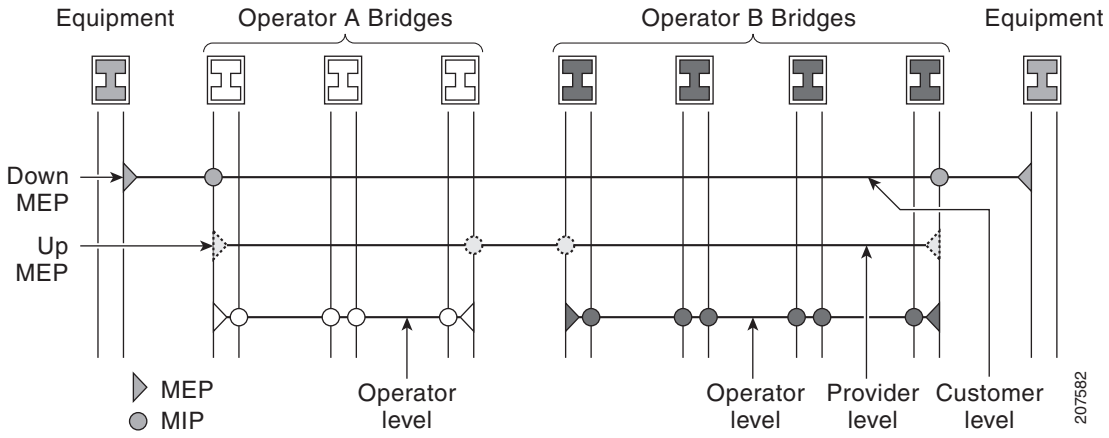


Figure 5 shows maintenance points at different levels. Because domains are allowed to nest but not intersect (see Figure 3), a MEP at a low level always corresponds with a MEP or MIP at a higher level. In addition, only a single MIP is allowed on any interface—this is generally created in the lowest domain that exists at the interface and that does not have a MEP.

Figure 5 CFM Maintenance Points at Different Levels



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:

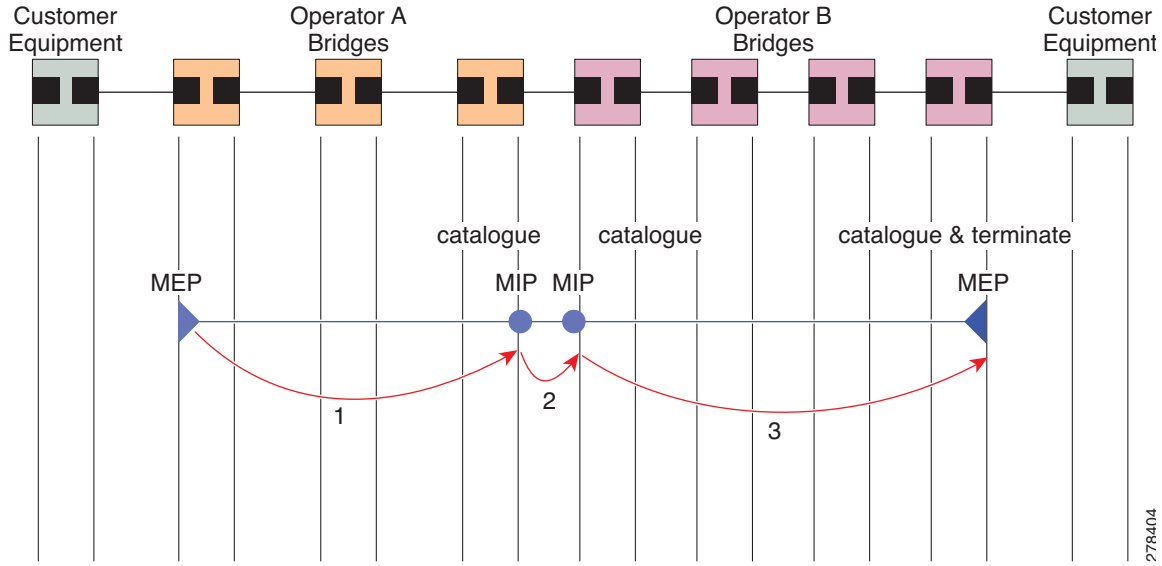
- Continuity Check (IEEE 802.1ag and ITU-T Y.1731), page 126
- Loopback (IEEE 802.1ag and ITU-T Y.1731), page 128
- Linktrace (IEEE 802.1ag and ITU-T Y.1731), page 129
- Exploratory Linktrace (Cisco), page 131
- Alarm Indication Signal (ITU-T Y.1731), page 132
- Delay and Jitter Measurement (ITU-T Y.1731), page 133

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)" section on page 129.

Figure 6 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.

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.
- A configured numeric identifier for the MEP (the MEP ID). Each MEP in the service must be configured with a different MEP ID.
- A sequence number.
- 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.

- 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).

The following 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 MEPs 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.

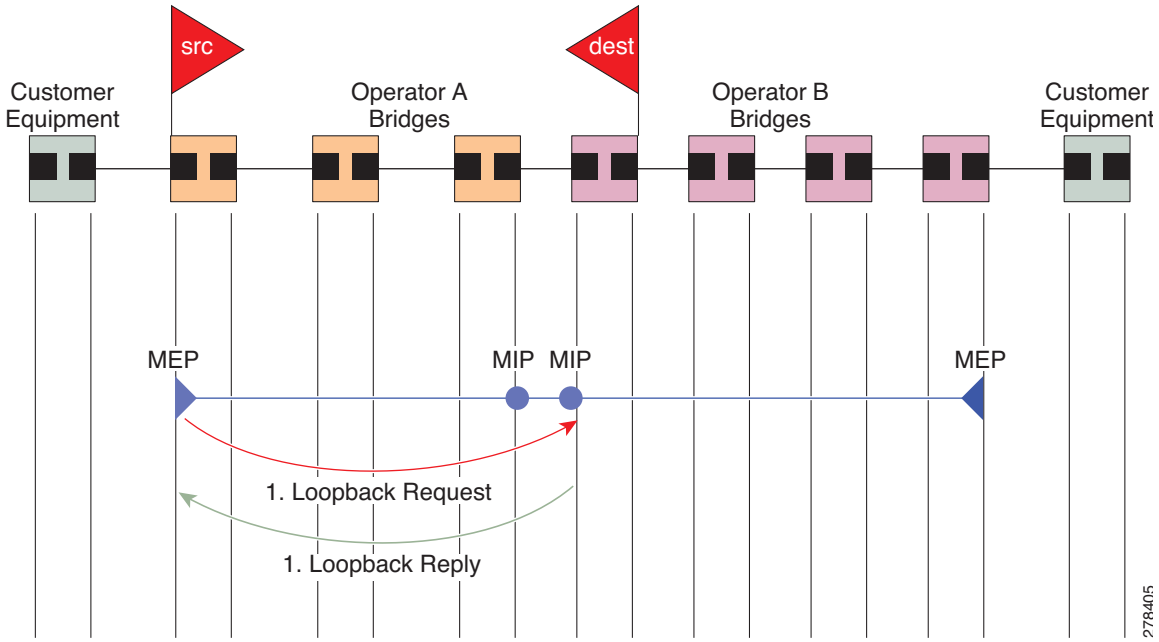
Out-of-sequence CCMs can also be detected by monitoring the sequence number in the received CCMs from each peer MEP. However, this is not considered a CCM defect.

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.

Figure 7 shows an example of CFM loopback message flow between a MEP and MIP.

Figure 7 Loopback Messages



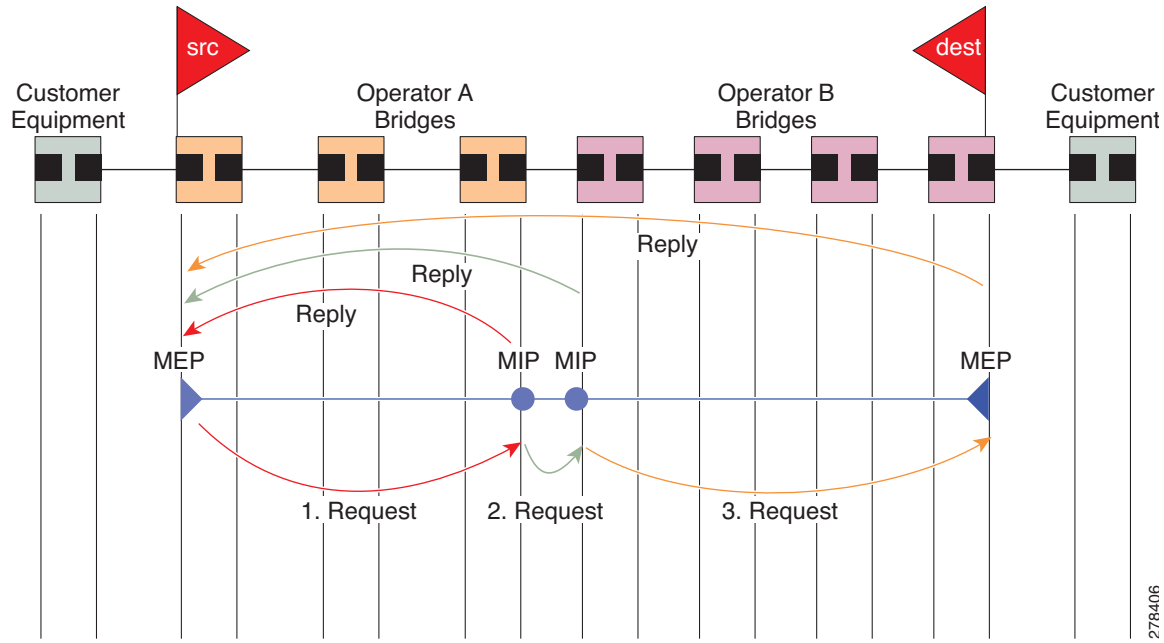
Loopback messages can be padded with user-specified data. This allows data corruption to be detected in the network. They also carry a sequence number which allows for out-of-order frames to be detected.

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.

Figure 8 shows an example of CFM linktrace message flow between MEPs and MIPs.

Figure 8 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.

Exploratory Linktrace (Cisco)

Exploratory Linktrace is a Cisco extension to the standard linktrace mechanism described above. It has two primary purposes:

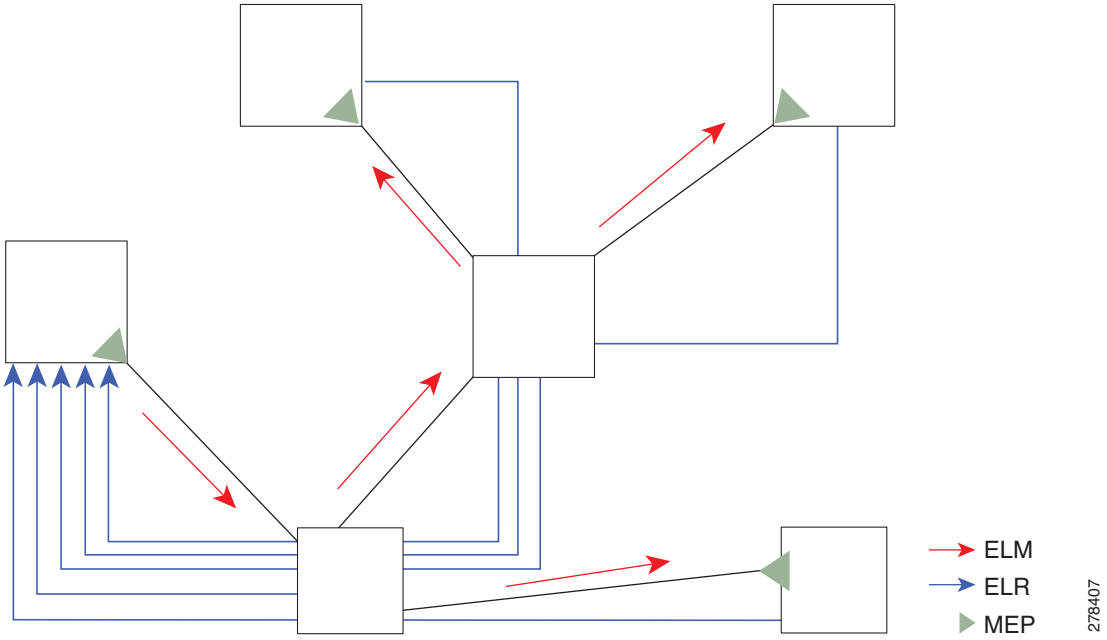
- Provide a mechanism to locate faults in cases where standard linktrace does not work, such as when a MAC address has never been seen previously in the network. For example, if a new MEP has been provisioned but is not working, standard linktrace does not help isolate a problem because no frames will ever have been received from the new MEP. Exploratory Linktrace overcomes this problem.
- Provide a mechanism to map the complete active network topology from a single node. This can only be done currently by examining the topology (for example, the STP blocking state) on each node in the network individually, and manually combining this information to create the overall active topology map. Exploratory linktrace allows this to be done automatically from a single node.

Exploratory Linktrace is implemented using the Vendor Specific Message (VSM) and Vendor Specific Reply (VSR) frames defined in ITU-T Y.1731. These allow vendor-specific extensions to be implemented without degrading interoperability. Exploratory Linktrace can safely be deployed in a network that includes other CFM implementations because those implementations will simply ignore the Exploratory Linktrace messages.

Exploratory Linktrace is initiated at the request of the administrator, and results in the local MEP sending a multicast Exploratory Linktrace message. Each MP in the network that receives the message sends an Exploratory Linktrace reply. MIPs that receive the message also forward it on. The initiating MEP uses all the replies to create a tree of the overall network topology.

Figure 9 show an example of the Exploratory Linktrace message flow between MEPs.

Figure 9 Exploratory Linktrace Messages and Replies



To avoid overloading the originating MEP with replies in a large network, responding MPs delay sending their replies for a random amount of time, and that time increases as the size of the network increases.

In a large network, there will be a corresponding large number of replies and the resulting topology map will be equally large. If only a part of the network is of interest, for example, because a problem has already been narrowed down to a small area, then the Exploratory Linktrace can be "directed" to start at a particular MP. Replies will thus only be received from MPs beyond that point in the network. The replies are still sent back to the originating MEP.

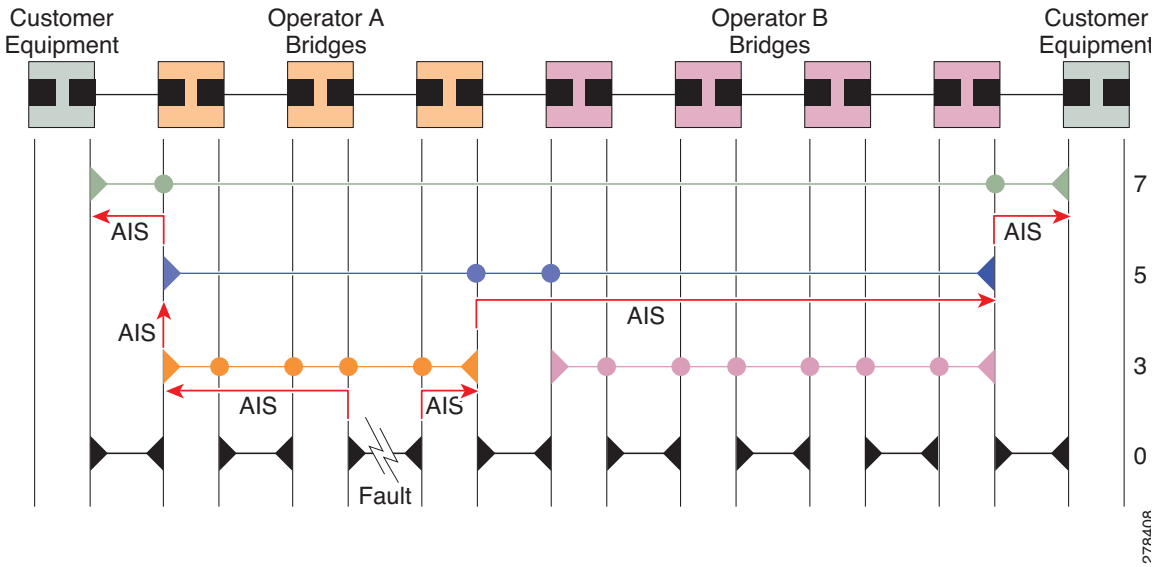
Alarm Indication Signal (ITU-T Y.1731)

Alarm Indication Signal (AIS) messages are used to rapidly notify MEPs when a fault is detected in the middle of a domain, in an event driven way. MEPs thereby learn of the fault much sooner than if they relied on detecting a loss of continuity, for example, failure to receive some number of consecutive CCMs.

Unlike all other CFM messages, AIS messages are injected into the middle of a domain, and sent outward toward the MEPs at the edge of the domain. Typically, AIS messages are injected by a MEP in a lower level domain. To put it another way, when a MEP sends AIS messages, they are sent in the opposite direction to other CFM messages sent by the MEP, and at a level above the MEP's own level. The AIS messages are received by the MEPs in the higher level domain, not by the peer MEPs in the same domain as the MEP sending the AIS. When a MEP receives an AIS message, it may itself send another AIS message at an even higher level.

Figure 10 show an example of AIS message flow. The maintenance domain levels are numbered at the right side of the diagram.

Figure 10 AIS Message Flow



AIS is only applicable in point-to-point networks. In multipoint networks with redundant paths, a failure at a low level does not necessarily result in a failure at a higher level, as the network may reconverge so as to route around the failed link.

AIS messages are typically sent by a MEP. However, AIS messages can also be sent when there is no MEP present, if a fault is detected in the underlying transport, such as if an interface goes down. In ITU-T Y.1731 these are referred to as *server MEPs*.

AIS messages are sent in response to a number of failure conditions:

- Detection of CCM defects, as described "Continuity Check (IEEE 802.1ag and ITU-T Y.1731)" section on page 126.

- Loss of continuity.
- Receipt of AIS messages.
- Failure in the underlying transport, such as when an interface is down.

Received AIS messages can be used to detect and act on failures more quickly than waiting for a loss of continuity. They can also be used to suppress any failure action, on the basis that the failure has already been detected at a lower level and will be handled there. This is described in ITU-T Y.1731; however, the former is often more useful.

Delay and Jitter Measurement (ITU-T Y.1731)

The router supports one-way and two-way delay measurement using two packet types:

- Delay Measurement Message (DMM)
- Delay Measurement Response (DMR)

These packets are unicast similar to loopback messages. The packets carry timestamps generated by the system time-of-day clock to support more accurate delay measurement, and also support an SLA manageability front-end.

However, unlike loopback messages, these message types can also measure one-way delay and jitter either from destination to source, or from source to destination.

For more information about SLA, see the "Ethernet SLA (Y.1731 Performance Monitoring)" section on page 135.

MEP Cross-Check

MEP cross-check supports configuration of a set of expected peer MEPs so that errors can be detected when any of the known MEPs are missing, or if any additional peer MEPs are detected that are not in the expected group.

The set of expected MEP IDs in the service is user-defined. Optionally, the corresponding MAC addresses can also be specified. CFM monitors the set of peer MEPs from which CCMs are being received. If no CCMs are ever received from one of the specified expected peer MEPs, or if a loss of continuity is detected, then a cross-check "missing" defect is detected. Similarly, if CCMs are received from a matching MEP ID but with the wrong source MAC address, a cross-check "missing" defect is detected. If CCMs are subsequently received that match the expected MEP ID, and if specified, the expected MAC address, then the defect is cleared.

Note While loss of continuity can be detected for any peer MEP, it is only treated as a defect condition if cross-check is configured.

If cross-check is configured and CCMs are received from a peer MEP with a MEP ID that is not expected, this is detected as a cross-check "unexpected" condition. However, this is not treated as a defect condition.

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.

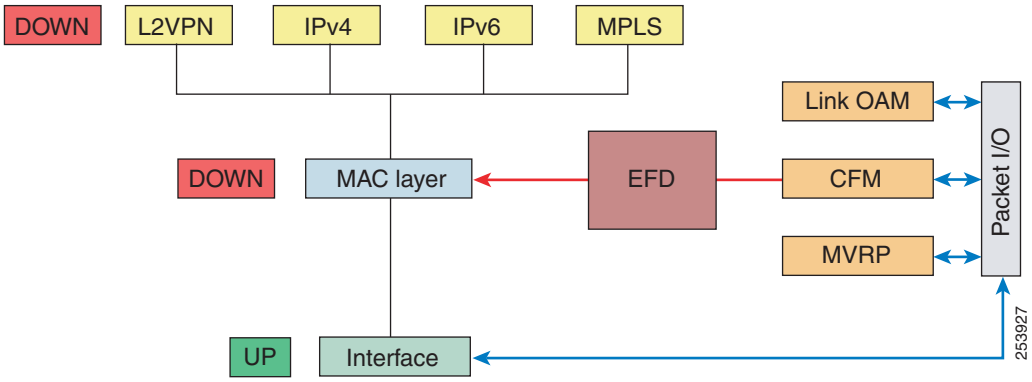
Unlike many other interface types, Ethernet interfaces do not have a line protocol, whose state is independent from that of the interface. For Ethernet interfaces, this role is handled by the physical-layer Ethernet protocol itself, and therefore if the interface is physically up, then it is available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

Figure 11 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 11 CFM Error Detection and EFD Trigger



Ethernet SLA (Y.1731 Performance Monitoring)

Customers require their service providers to conform to a Service Level Agreement (SLA). Consequently, service providers must be able to monitor the performance characteristics of their networks. Likewise, customers also want to monitor the performance characteristics of their networks. Cisco provides Y.1731 performance monitoring using the Cisco Ethernet SLA feature.

An SLA defines a set of criteria that guarantees a minimum level of service for customers using a service provider network. The criteria can cover many different areas, including latency, jitter, frame loss, and availability.

The Cisco Ethernet SLA feature conforms to the following standards:

- IEEE 802.1ag
- ITU-T Y.1731

The Cisco Ethernet SLA feature provides the architecture to monitor a network at Layer 2. This architecture provides functions such as collecting, storing, displaying, and analyzing SLA statistics. These SLA statistics can be stored and displayed in various ways, so that statistical analysis can be performed.

Ethernet SLA provides the framework for performing the following major functions of performance monitoring:

- Sending probes consisting of one or more packets to measure performance

  Ethernet SLA provides a flexible mechanism for sending SLA probes to measure performance. Probes can consist of either CFM loopback or CFM delay measurement packets. Options are available to modify how often the packets are sent, and to specify the attributes of the probe packets such as the size and priority.

- Scheduling of operations consisting of periodic probes.

  A flexible mechanism is provided by Ethernet SLA to specify how often each probe should be executed, how long it should last, and when the first probe should start. Probes can be scheduled to run back-to-back to provide continuous measurements, or at a defined interval ranging from once a minute to once a week.

- Collecting and storing results.

  Ethernet SLA provides flexibility to specify which performance parameters should be collected and stored for each measurement probe. Performance parameters include frame delay and jitter (inter-frame delay variation). For each performance parameter, either each individual result can be stored, or the results can be aggregated by storing a counter of the number of results that fall within a particular range. A configurable amount of historical data can also be stored as well as the latest results.

- Analyzing and displaying results.

  Ethernet SLA performs some basic statistical analysis on the collected results, such as calculating the minimum, maximum, mean and standard deviation. It also records whether any of the probe packets were lost or misordered, or if there is any reason why the results may not be a true reflection of the performance (for example if a big jump in the local time-of-day clock was detected during the time when the measurements were being made).

Ethernet SLA Concepts

To successfully configure the Cisco Ethernet SLA feature, you should understand the following concepts:

- Ethernet SLA Statistic, page 136
- Ethernet SLA Measurement Packet, page 137
- Ethernet SLA Sample, page 137
- Ethernet SLA Probe, page 137
- Ethernet SLA Burst, page 137
- Ethernet SLA Schedule, page 137
- Ethernet SLA Bucket, page 138
- Ethernet SLA Aggregation Bin, page 138
- Ethernet SLA Operation Profile, page 138
- Ethernet SLA Operation, page 138
- Ethernet SLA On-Demand Operation, page 138

Ethernet SLA Statistic

A *statistic* in Ethernet SLA is a single performance parameter. The following statistics can be measured by Ethernet SLA:

- Round-trip delay
- Round-trip jitter
- One-way delay from source to destination
- One-way jitter from source to destination
- One-way delay from destination to source

- One-way jitter from destination to source

Note Not all statistics can be measured by all types of packet. For example, one-way statistics cannot be measured when using CFM loopback packets.

Ethernet SLA Measurement Packet

An Ethernet SLA *measurement packet* is a single protocol message and corresponding reply that is sent on the network for the purpose of making SLA measurements. The following types of measurement packet are supported:

- CFM Delay Measurement (Y.1731 DMM/DMR packets)—CFM delay measurement packets contain timestamps within the packet data that can be used for accurate measurement of frame delay and jitter. These packets can be used to measure round-trip or one-way statistics; however, the size of the DMM/DMR packets cannot be modified.
- CFM loopback (LBM/LBR)—CFM loopback packets are less accurate, but can be used if the peer device does not support DMM/DMR packets. Only round-trip statistics can be measured because these packets do not contain timestamps. However, loopback packets can be padded, so measurements can be made using frames of a specific size.

Ethernet SLA Sample

A *sample* is a single result—a number—that relates to a given statistic. For some statistics such as round-trip delay, a sample can be measured using a single measurement packet. For other statistics such as jitter, obtaining a sample requires two measurement packets.

Ethernet SLA Probe

A *probe* is a sequence of measurement packets used to gather SLA samples for a specific set of statistics. The measurement packets in a probe are of a specific type (for example, CFM delay measurement or CFM loopback) and have specific attributes, such as the frame size and priority.

Note A single probe can collect data for different statistics at the same time, using the same measurement packets (for example, one-way delay and round-trip jitter).

Ethernet SLA Burst

Within a probe, measurement packets can either be sent individually, or in bursts. A *burst* contains two or more packets sent within a short interval apart. Each burst can last up to one minute, and bursts can follow each other immediately to provide continuous measurement within the probe.

For statistics that require two measurement packets for each sample (such as jitter), samples are only calculated based on measurement packets in the same burst. For all statistics, it is more efficient to use bursts than to send individual packets.

Ethernet SLA Schedule

An Ethernet SLA *schedule* describes how often probes are sent, how long each probe lasts, and at what time the first probe starts.

Ethernet SLA Bucket

For a particular statistic, a *bucket* is a collection of results that were gathered during a particular period of time. All of the samples for measurements that were initiated during the period of time represented by a bucket are stored in that bucket. Buckets allow results from different periods of time to be compared (for example, peak traffic to off-peak traffic).

By default, a separate bucket is created for each probe; that is, the bucket represents the period of time starting at the same time as the probe started, and continuing for the duration of the probe. The bucket will therefore contain all the results relating to measurements made by that probe.

Ethernet SLA Aggregation Bin

Rather than storing each sample separately within a bucket, an alternative is to aggregate the samples into bins. An *aggregation bin* is a range of sample values, and contains a counter of the number of samples that were received that fall within that range. The set of bins forms a histogram. When aggregation is enabled, each bucket contains a separate set of bins. See Figure 12 on page 196.

Ethernet SLA Operation Profile

An *operation profile* is a configuration entity that defines the following aspects of an operation:

- What packet types to send and in what quantities (probe and burst configuration)
- What statistics to measure, and how to aggregate them
- When to schedule the probes

An operation profile by itself does not cause any packets to be sent or statistics collected, but is used to create operation instances.

Ethernet SLA Operation

An *operation* is an instance of a given operation profile that is actively collecting performance data. Operation instances are created by associating an operation profile with a given source (an interface and MEP) and with a given destination (a MEP ID or MAC address). Operation instances exist for as long as the configuration is applied, and they run for an indefinite duration on an ongoing basis.

Ethernet SLA On-Demand Operation

An *on-demand operation* is a method of Ethernet SLA operation that can be run on an as-needed basis for a specific and finite period of time. This can be useful in situations such as when you are starting a new service or modifying the parameters for a service to verify the impact of the changes, or if you want to run a more detailed probe when a problem is detected by an ongoing scheduled operation.

On-demand operations do not use profiles and have a finite duration. The statistics that are collected are discarded after a finite time after the operation completes (two weeks), or when you manually clear them.

On-demand operations are not persistent so they are lost during certain events such as a card reload or Minimal Disruptive Restart (MDR).

Statistics Measurement and Ethernet SLA Operations Overview

Ethernet SLA statistics measurement for network performance is performed by sending packets and storing data metrics such as:

- Round-trip delay time—The time for a packet to travel from source to destination and back to source again.
- Round-trip jitter—The variance in round-trip delay time (latency).
- One-way delay and jitter—The router also supports measurement of one-way delay or jitter from source to destination, or from destination to source.

In addition to these metrics, the following statistics are also kept for SLA probe packets:

- Packet loss count
- Packet corruption event
- Out-of-order event

Counters for packet loss, corruption and out-of-order packets are kept for each bucket, and in each case, a percentage of the total number of samples for that bucket is reported (for example, 4% packet corruption). For delay and jitter statistics, the minimum, maximum, mean and standard deviation for the whole bucket are reported, as well as the individual samples or aggregated bins.

When aggregation is enabled using the **aggregate** command, bins are created to store a count of the samples that fall within a certain value range, which is set by the **width** keyword. Only a counter of the number of results that fall within the range for each bin is stored. This uses less memory than storing individual results. When aggregation is not used, each sample is stored separately, which can provide a more accurate statistics analysis for the operation, but it is highly memory-intensive due to the independent storage of each sample.

A bucket represents a time period during which statistics are collected. All the results received during that time period are recorded in the corresponding bucket. If aggregation is enabled, each bucket has its own set of bins and counters, and only results relating to the measurements initiated during the time period represented by the bucket are included in those counters.

By default, there is a separate bucket for each probe. The time period is determined by how long the probe lasts (configured by the **probe**, **send (SLA)**, and **schedule (SLA)** commands).You can modify the size of buckets so that you can have more buckets per probe or fewer buckets per probe (less buckets allows the results from multiple probes to be included in the same bucket). Changing the size of the buckets for a given metric clears all stored data for that metric. All existing buckets are deleted and new buckets are created.

Scheduled SLA operation profiles run indefinitely, according to a configured schedule, and the statistics that are collected are stored in a rolling buffer, where data in the oldest bucket is discarded when a new bucket needs to be recorded.

Configuration Overview of Scheduled Ethernet SLA Operations

When you configure a scheduled Ethernet SLA operation, you perform the following basic steps:

1. Configure global profiles to define how packets are sent in each probe, how the probes are scheduled, and how the results are stored.
2. Configure operations from a specific local MEP to a specific peer MEP using these profiles.

Note Certain Ethernet SLA configurations use large amounts of memory which can affect the performance of other features on the system. For more information, see the "Configuring Ethernet SLA" section on page 169.

How to Configure Ethernet OAM

This section provides the following configuration procedures:

- Configuring Ethernet Link OAM, page 140
- Configuring Ethernet CFM, page 149
- Configuring Ethernet SLA, page 169

Configuring Ethernet Link OAM

Custom EOAM settings can be configured and shared on multiple interfaces by creating an EOAM profile in Ethernet configuration mode and then attaching the profile to individual interfaces. The profile configuration does not take effect until the profile is attached to an interface. After an EOAM profile is attached to an interface, individual EOAM features can be configured separately on the interface to override the profile settings when desired.

This section describes how to configure an EOAM profile and attach it to an interface in the following procedures:

- Configuring an Ethernet OAM Profile, page 140
- Attaching an Ethernet OAM Profile to an Interface, page 145
- Configuring Ethernet OAM at an Interface and Overriding the Profile Configuration, page 146
- Verifying the Ethernet OAM Configuration, page 148

Configuring an Ethernet OAM Profile

Perform the following steps to configure an Ethernet OAM profile.

SUMMARY STEPS

1. **configure**
2. **ethernet oam profile** *profile-name*
3. **link-monitor**
4. **frame window** *window*
5. **frame threshold low** *threshold*
6. **frame-period window** *window*
7. **frame-period threshold low** *threshold*
8. **frame-seconds window** *window*

9. **frame-seconds threshold low** *threshold*
10. **exit**
11. **mib-retrieval**
12. **connection timeout** *seconds*
13. **hello-interval** {**100ms** | **1s**}
14. **mode** {**active** | **passive**}
15. **require-remote mode** {**active** | **passive**}
16. **require-remote link-monitoring**
17. **require-remote mib-retrieval**
18. **action capabilities-conflict** {**disable** | **efd** | **error-disable-interface**}
19. **action critical-event** {**disable** | **error-disable-interface**}
20. **action discovery-timeout** {**disable** | **efd** | **error-disable-interface** }
21. **action dying-gasp** {**disable** | **error-disable-interface**}
22. **action high-threshold** {**error-disable-interface** | **log**}
23. **action remote-loopback disable**
24. **action session-down** {**disable** | **efd** | **error-disable-interface**}
25. **action session-up disable**
26. **action uni-directional link-fault** {**disable** | **efd** | **error-disable-interface**}
27. **action wiring-conflict** {**disable** | **efd** | **log**}
28. **commit**
29. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/0/CPU0:router# configure terminal`	Enters global configuration mode.
Step 2	**ethernet oam profile** *profile-name* **Example:** `RP/0/0/CPU0:router(config)# ethernet oam profile Profile_1`	Creates a new Ethernet Operations, Administration and Maintenance (OAM) profile and enters Ethernet OAM configuration mode.
Step 3	**link-monitor** **Example:** `RP/0/0/CPU0:router(config-eoam)# link-monitor`	Enters the Ethernet OAM link monitor configuration mode.

	Command or Action	Purpose
Step 4	**frame window** *window* **Example:** `RP/0/0/CPU0:router(config-eoam-lm)# frame window 60`	(Optional) Configures the frame window size (in milliseconds) of an OAM frame error event. The range is 1000 to 60000. The default value is 1000.
Step 5	**frame threshold low** *threshold* **high** *threshold* **Example:** `RP/0/0/CPU0:router(config-eoam-lm)# frame threshold low 10000000 high 60000000`	(Optional) Configures the thresholds (in symbols) that triggers an Ethernet OAM frame error event. The high threshold is optional and is configurable only in conjunction with the low threshold. The range is 0 to 60000000. The default low threshold is 1.
Step 6	**frame-period window** *window* **Example:** `RP/0/0/CPU0:router(config-eoam-lm)# frame-period window 60000`	(Optional) Configures the window size (in milliseconds) for an Ethernet OAM frame-period error event. The range is 100 to 60000. The default value is 1000.
Step 7	**frame-period threshold low** *threshold* **high** *threshold* `RP/0/0/CPU0:router(config-eoam-lm)# frame-period threshold low 100 high 1000000`	(Optional) Configures the thresholds (in frames) that trigger an Ethernet OAM frame-period error event. The high threshold is optional and is configurable only in conjunction with the low threshold. The range is 0 to 1000000. The default low threshold is 60000.
Step 8	**frame-seconds window** *window* **Example:** `RP/0/0/CPU0:router(config-eoam-lm)# frame-seconds window 900000`	(Optional) Configures the window size (in milliseconds) for the OAM frame-seconds error event. The range is 10000 to 900000. The default value is 6000.
Step 9	**frame-seconds threshold low** *threshold* **high** *threshold* **Example:** `RP/0/0/CPU0:router(config-eoam-lm)# frame-seconds threshold 3 threshold 900`	(Optional) Configures the thresholds (in seconds) that trigger a frame-seconds error event. The high threshold value can be configured only in conjunction with the low threshold value. The range is 1 to 900 The default value is 1.
Step 10	**exit** **Example:** `RP/0//CPU0:router(config-eoam-lm)# exit`	Exits back to Ethernet OAM mode.
Step 11	**mib-retrieval** **Example:** `RP/0/0/CPU0:router(config-eoam)# mib-retrieval`	Enables MIB retrieval in an Ethernet OAM profile or on an Ethernet OAM interface.

	Command or Action	Purpose
Step 12	**connection timeout** *seconds* **Example:** `RP/0/0/CPU0:router(config-eoam)# connection timeout 30`	Configures the timeout value (in seconds) for an Ethernet OAM session. The range is 2 to 30. The default value is 5.
Step 13	**hello-interval** {**100ms**|**1s**} `Example:` `RP/0/0/CPU0:router(config-eoam)# hello-interval 100ms`	Configures the time interval between hello packets for an Ethernet OAM session. The default is 1 second (**1s**).
Step 14	**mode** {**active**|**passive**} `Example:` `RP/0/0/CPU0:router(config-eoam)# mode passive`	Configures the Ethernet OAM mode. The default is active.
Step 15	**require-remote mode** {**active**|**passive**} **Example:** `RP/0/0/CPU0:router(config-eoam)# require-remote mode active`	Requires that active mode or passive mode is configured on the remote end before the OAM session becomes active.
Step 16	**require-remote link-monitoring** **Example:** `RP/0/0/CPU0:router(config-eoam)# require-remote link-monitoring`	Requires that link-monitoring is configured on the remote end before the OAM session becomes active.
Step 17	**require-remote mib-retrieval** **Example:** `RP/0/0/CPU0:router(config-eoam)# require-remote mib-retrieval`	Requires that MIB-retrieval is configured on the remote end before the OAM session becomes active.
Step 18	**action capabilities-conflict** {**disable** | **efd** | **error-disable-interface**} **Example:** `RP/0/0/CPU0:router(config-eoam)# action capabilities-conflict efd`	Specifies the action that is taken on an interface when a capabilities-conflict event occurs. The default action is to create a syslog entry. **Note** If you change the default, the **log** keyword option is available in Interface Ethernet OAM configuration mode to override the profile setting and log the event for the interface when it occurs.
Step 19	**action critical-event** {**disable** | **error-disable-interface**} **Example:** `RP/0/0/CPU0:router(config-eoam)# action critical-event error-disable-interface`	Specifies the action that is taken on an interface when a critical-event notification is received from the remote Ethernet OAM peer. The default action is to create a syslog entry. **Note** If you change the default, the **log** keyword option is available in Interface Ethernet OAM configuration mode to override the profile setting and log the event for the interface when it occurs.

	Command or Action	Purpose
Step 20	**action discovery-timeout** {**disable** | **efd** | **error-disable-interface**} **Example:** `RP/0/0/CPU0:router(config-eoam)# action discovery-timeout efd`	Specifies the action that is taken on an interface when a connection timeout occurs. The default action is to create a syslog entry. **Note** If you change the default, the **log** keyword option is available in Interface Ethernet OAM configuration mode to override the profile setting and log the event for the interface when it occurs.
Step 21	**action dying-gasp** {**disable** | **error-disable-interface**} **Example:** `RP/0/0/CPU0:router(config-eoam)# action dying-gasp error-disable-interface`	Specifies the action that is taken on an interface when a dying-gasp notification is received from the remote Ethernet OAM peer. The default action is to create a syslog entry. **Note** If you change the default, the **log** keyword option is available in Interface Ethernet OAM configuration mode to override the profile setting and log the event for the interface when it occurs.
Step 22	**action high-threshold** {**error-disable-interface** | **log**} **Example:** `RP/0/0/CPU0:router(config-eoam)# action high-threshold error-disable-interface`	Specifies the action that is taken on an interface when a high threshold is exceeded. The default is to take no action when a high threshold is exceeded. **Note** If you change the default, the **disable** keyword option is available in Interface Ethernet OAM configuration mode to override the profile setting and take no action at the interface when the event occurs.
Step 23	**action remote-loopback disable** **Example:** `RP/0/0/CPU0:router(config-eoam)# action remote-loopback disable`	Specifies that no action is taken on an interface when a remote-loopback event occurs. The default action is to create a syslog entry. **Note** If you change the default, the **log** keyword option is available in Interface Ethernet OAM configuration mode to override the profile setting and log the event for the interface when it occurs.
Step 24	**action session-down** {**disable** | **efd** | **error-disable-interface**} **Example:** `RP/0/0/CPU0:router(config-eoam)# action session-down efd`	Specifies the action that is taken on an interface when an Ethernet OAM session goes down. **Note** If you change the default, the **log** keyword option is available in Interface Ethernet OAM configuration mode to override the profile setting and log the event for the interface when it occurs.
Step 25	**action session-up disable** **Example:** `RP/0/0/CPU0:router(config-eoam)# action session-up disable`	Specifies that no action is taken on an interface when an Ethernet OAM session is established. The default action is to create a syslog entry. **Note** If you change the default, the **log** keyword option is available in Interface Ethernet OAM configuration mode to override the profile setting and log the event for the interface when it occurs.

	Command or Action	Purpose
Step 26	**action uni-directional link-fault** {**disable** | **efd** | **error-disable-interface**}	Specifies the action that is taken on an interface when a link-fault notification is received from the remote Ethernet OAM peer. The default action is to create a syslog entry. **Note** If you change the default, the **log** keyword option is available in Interface Ethernet OAM configuration mode to override the profile setting and log the event for the interface when it occurs. **Note**
Step 27	**action wiring-conflict** {**disable** | **efd** | **log**} **Example:** `RP/0/0/CPU0:router(config-eoam)# action session-down efd`	Specifies the action that is taken on an interface when a wiring-conflict event occurs. The default is to put the interface into error-disable state. **Note** If you change the default, the **error-disable-interface** keyword option is available in Interface Ethernet OAM configuration mode to override the profile setting and put the interface into error-disable state when the event occurs.
Step 28	**commit** **Example:** `RP/0/0/CPU0:router(config-if)# commit`	Saves the configuration changes to the running configuration file and remains within the configuration session.
Step 29	**end** **Example:** `RP/0/0/CPU0:router(config-if)# end`	Ends the configuration session and exits to the EXEC mode.

Attaching an Ethernet OAM Profile to an Interface

Perform the following steps to attach an Ethernet OAM profile to an interface:

SUMMARY STEPS

1. **configure**
2. **interface** [**FastEthernet** | **GigabitEthernet** | **TenGigE**] *interface-path-id*
3. **ethernet oam**
4. **profile** *profile-name*
5. **commit**
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/0/CPU0:router# configure terminal`	Enters global configuration mode.
Step 2	**interface** [**FastEthernet** | **GigabitEthernet** | **TenGigE**] *interface-path-id* **Example:** `RP/0/0/CPU0:router(config)# interface TenGigE 0/1/0/0`	Enters interface configuration mode and specifies the Ethernet interface name and notation *rack/slot/module/port*. **Note** The example indicates an 8-port 10-Gigabit Ethernet interface in modular services card slot 1.
Step 3	**ethernet oam** **Example:** `RP/0/0/CPU0:router(config-if)# ethernet oam`	Enables Ethernet OAM and enters interface Ethernet OAM configuration mode.
Step 4	**profile** *profile-name* **Example:** `RP/0/0/CPU0:router(config-if-eoam)# profile Profile_1`	Attaches the specified Ethernet OAM profile (*profile-name*), and all of its configuration, to the interface.
Step 5	**commit** **Example:** `RP/0/0/CPU0:router(config-if)# commit`	Saves the configuration changes to the running configuration file and remains within the configuration session.
Step 6	**end** **Example:** `RP/0/0/CPU0:router(config-if)# end`	Ends the configuration session and exits to the EXEC mode.

Configuring Ethernet OAM at an Interface and Overriding the Profile Configuration

Using an EOAM profile is an efficient way of configuring multiple interfaces with a common EOAM configuration. However, if you want to use a profile but also change the behavior of certain functions for a particular interface, then you can override the profile configuration. To override certain profile settings that are applied to an interface, you can configure that command in interface Ethernet OAM configuration mode to change the behavior for that interface.

In some cases, only certain keyword options are available in interface Ethernet OAM configuration due to the default settings for the command. For example, without any configuration of the **action** commands, several forms of the command have a default behavior of creating a syslog entry when a profile is created and applied to an interface. Therefore, the **log** keyword is not available in Ethernet OAM configuration for these commands in the profile because it is the default behavior. However, the **log** keyword is available in Interface Ethernet OAM configuration if the default is changed in the profile configuration so you can retain the action of creating a syslog entry for a particular interface.

To see all of the default Ethernet OAM configuration settings, see the "Verifying the Ethernet OAM Configuration" section on page 148.

To configure Ethernet OAM settings at an interface and override the profile configuration, perform the following steps:

SUMMARY STEPS

1. **configure**
2. **interface** [**FastEthernet** | **GigabitEthernet** | **TenGigE**] *interface-path-id*
3. **ethernet oam**
4. *interface-Ethernet-OAM-command*
5. **commit**
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/0/CPU0:router# configure terminal`	Enters global configuration mode.
Step 2	**interface** [**FastEthernet** | **GigabitEthernet** | **TenGigE**] *interface-path-id* **Example:** `RP/0/0/CPU0:router(config)# interface TenGigE 0/1/0/0`	Enters interface configuration mode and specifies the Ethernet interface name and notation *rack/slot/module/port*. **Note** The example indicates an 8-port 10-Gigabit Ethernet interface in modular services card slot 1.
Step 3	**ethernet oam** **Example:** `RP/0/0/CPU0:router(config-if)# ethernet oam`	Enables Ethernet OAM and enters interface Ethernet OAM configuration mode.
Step 4	*interface-Ethernet-OAM-command* **Example:** `RP/0/0/CPU0:router(config-if-eoam)# action capabilities-conflict error-disable-interface`	Configures a setting for an Ethernet OAM configuration command and overrides the setting for the profile configuration, where *interface-Ethernet-OAM-command* is one of the supported commands on the platform in interface Ethernet OAM configuration mode.
Step 5	**commit** **Example:** `RP/0/0/CPU0:router(config-if)# commit`	Saves the configuration changes to the running configuration file and remains within the configuration session.
Step 6	**end** **Example:** `RP/0/0/CPU0:router(config-if)# end`	Ends the configuration session and exits to the EXEC mode.

Verifying the Ethernet OAM Configuration

Use the **show ethernet oam configuration** command to display the values for the Ethernet OAM configuration for a particular interface, or for all interfaces. The following example shows the default values for Ethernet OAM settings:

Note Some of these settings are not supported on certain platforms, but the defaults are still reported. On the Cisco XR 12000 Series Router, the following areas are unsupported:

- Remote loopback
- Symbol period window
- Symbol period thresholds
- Uni-directional link-fault detection

```
RP/0/0/CPU0:router# show ethernet oam configuration
Thu Aug  5 22:07:06.870 DST
GigabitEthernet0/4/0/0:
  Hello interval:                                      1s
  Link monitoring enabled:                              Y
  Remote loopback enabled:                              N
  Mib retrieval enabled:                                N
  Uni-directional link-fault detection enabled:         N
  Configured mode:                                 Active
  Connection timeout:                                   5
  Symbol period window:                                 0
  Symbol period low threshold:                          1
  Symbol period high threshold:                      None
  Frame window:                                      1000
  Frame low threshold:                                  1
  Frame high threshold:                              None
  Frame period window:                               1000
  Frame period low threshold:                           1
  Frame period high threshold:                       None
  Frame seconds window:                             60000
  Frame seconds low threshold:                          1
  Frame seconds high threshold:                      None
  High threshold action:                             None
  Link fault action:                                  Log
  Dying gasp action:                                  Log
  Critical event action:                              Log
  Discovery timeout action:                           Log
  Capabilities conflict action:                       Log
  Wiring conflict action:                    Error-Disable
  Session up action:                                  Log
  Session down action:                                Log
  Remote loopback action:                             Log
  Require remote mode:                             Ignore
  Require remote MIB retrieval:                         N
  Require remote loopback support:                      N
  Require remote link monitoring:                       N
```

Configuring Ethernet CFM

To configure Ethernet CFM, perform the following tasks:

- Configuring a CFM Maintenance Domain, page 149 (required)
- Configuring Services for a CFM Maintenance Domain, page 150 (required)
- Enabling and Configuring Continuity Check for a CFM Service, page 152 (optional)
- Configuring Automatic MIP Creation for a CFM Service, page 154 (optional)
- Configuring Cross-Check on a MEP for a CFM Service, page 156 (optional)
- Configuring Other Options for a CFM Service, page 158 (optional)
- Configuring CFM MEPs, page 160 (required)
- Configuring Y.1731 AIS, page 162 (optional)
- Configuring EFD for a CFM Service, page 166 (optional)
- Verifying the CFM Configuration, page 168
- Troubleshooting Tips, page 168

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/0/0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**ethernet cfm** **Example:** `RP/0/0/CPU0:router(config)# ethernet cfm`	Enters Ethernet Connectivity Fault Management (CFM) configuration mode.

	Command or Action	Purpose
Step 3	**domain** *domain-name* **level** *level-value* [**id** [**null**] [**dns** *DNS-name*] [**mac** *H.H.H*] [**string** *string*]] **Example:** `RP/0/0/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** *minutes* **size** *entries* **Example:** `RP/0/0/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/0/0/CPU0:router(config-cfm-dmn)# commit`	Saves configuration changes. • 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 Services for a CFM Maintenance Domain

You can configure up to 32000 CFM services for a maintenance domain.

Restrictions

When you configure services for a CFM maintenance domain, consider the following restrictions:

- VPLS configuration (L2VPN bridge groups and bridge-domains) is supported with CFM down MEPs only.
- Policy-Based Tunnel Selection (PBTS) in the core network is not supported.

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** [**string** *text*] | [**number** *number*] | [**vlan-id** *id-number*] | [**vpn-id** *oui-vpnid*]]
5. **end**
   or
   commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**ethernet cfm** **Example:** `RP/0/0/CPU0:router(config)# ethernet cfm`	Enters Ethernet CFM configuration mode.
Step 3	**domain** *domain-name* **level** *level-value* [**id** [**null**] [**dns** *DNS-name*] [**mac** *H.H.H*] [**string** *string*]] **Example:** `RP/0/0/CPU0:router(config-cfm)# domain Domain_One level 1 id string D1`	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.

	Command or Action	Purpose
Step 4	**service** *service-name* {**down-meps** | **xconnect group** *xconnect-group-name* **p2p** *xconnect-name*}[**id** [**string** *text*] | [**number** *number*] | [**vlan-id** *id-number*] | [**vpn-id** *oui-vpnid*]] **Example:** `RP/0/0/CPU0:router(config-cfm-dmn)# service Bridge_Service bridge group BD1 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 an xconnect where MIPs and up MEPs will be created. The **id** sets the short MA name.
Step 5	**end** or **commit** **Example:** `RP/0/0/CPU0:router(config-cfm-dmn-svc)# commit`	Saves configuration changes. • 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.

Enabling and Configuring Continuity Check for a CFM Service

The Cisco XR 12000 Series Router supports Continuity Check as defined in the IEEE 802.1ag specification, and supports CCMs intervals of 100 ms and longer. The overall packet rates for CCM messages are up to 2000 CCMs-per-second sent, and up to 2000 CCMs-per-second received, per card.

Note If Ethernet SLA is configured, the overall combined packet rate for CCMs and SLA frames is 2000 frames-per-second in each direction, per card.

To configure Continuity Check 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* {**down-meps** | **xconnect group** *xconnect-group-name* **p2p** *xconnect-name*}[**id** [**string** *text*] | [**number** *number*] | [**vlan-id** *id-number*] | [**vpn-id** *oui-vpnid*]]

5. **continuity-check interval** *time* [**loss-threshold** *threshold*]
6. **continuity-check archive hold-time** *minutes*
7. **continuity-check loss auto-traceroute**
8. **end**
   or
   commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**ethernet cfm** **Example:** `RP/0/0/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/0/0/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** [**string** *text*] | [**number** *number*] | [**vlan-id** *id-number*] | [**vpn-id** *oui-vpnid*]] **Example:** `RP/0/0/CPU0:router(config-cfm-dmn)# service Bridge_Service bridge group BD1 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 an 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/0/0/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/0/0/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.

	Command or Action	Purpose
Step 7	**continuity-check loss auto-traceroute** **Example:** `RP/0/0/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:** `RP/0/0/CPU0:router(config-cfm-dmn-svc)# commit`	Saves configuration changes. • 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 on page 124.

To configure automatic MIP creation 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* {**down-meps | xconnect group** *xconnect-group-name* **p2p** *xconnect-name*}[**id** [**string** *text*] | [**number** *number*] | [**vlan-id** *id-number*] | [**vpn-id** *oui-vpnid*]]
5. **mip auto-create {all | lower-mep-only}**
6. **end**
   or
   commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**ethernet cfm** **Example:** `RP/0/0/CPU0:router# ethernet cfm`	Enters the 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/0/0/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** [**string** *text*] | [**number** *number*] | [**vlan-id** *id-number*] | [**vpn-id** *oui-vpnid*]] **Example:** `RP/0/0/CPU0:router(config-cfm-dmn)# service Bridge_Service bridge group BD1 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 an xconnect where MIPs and up MEPs will be created. The **id** sets the short MA name.

	Command or Action	Purpose
Step 5	**mip auto-create** {**all** | **lower-mep-only**} **Example:** `RP/0/0/CPU0:router(config-cfm-dmn-svc)# mip auto-create all`	(Optional) Enables the automatic creation of MIPs in an xconnect.
Step 6	**end** or **commit** **Example:** `RP/0/0/CPU0:router(config-cfm-dmn-svc)# commit`	Saves configuration changes. • 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 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* {**down-meps** | **xconnect group** *xconnect-group-name* **p2p** *xconnect-name*}[**id** [**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/0/0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**ethernet cfm** **Example:** `RP/0//CPU0:router# ethernet cfm`	Enters the 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/0/0/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** [**string** *text*] | [**number** *number*] | [**vlan-id** *id-number*] | [**vpn-id** *oui-vpnid*]] **Example:** `RP/0/0/CPU0:router(config-cfm-dmn)# service Bridge_Service bridge group BD1 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 an xconnect where MIPs and up MEPs will be created. The **id** sets the short MA name.
Step 5	**mep crosscheck** **Example:** `RP/0/0/CPU0:router(config-cfm-dmn-svc)# mep crosscheck mep-id 10`	Enters CFM MEP crosscheck configuration mode.

	Command or Action	Purpose
Step 6	**mep-id** *mep-id-number* [**mac-address** *mac-address*] **Example:** `RP/0/0/CPU0:router(config-cfm-xcheck)# mep-id 10`	Enables cross-check on a MEP. **Note** 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:** `RP/0/0/CPU0:router(config-cfm-xcheck)# commit`	Saves configuration changes. • 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 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* {**down-meps | xconnect group** *xconnect-group-name* **p2p** *xconnect-name*}[**id** [**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/0/0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**ethernet cfm** **Example:** `RP/0/0/CPU0:router# ethernet cfm`	Enters the 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/0/0/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** [**string** *text*] | [**number** *number*] | [**vlan-id** *id-number*] | [**vpn-id** *oui-vpnid*]] **Example:** `RP/0/0/CPU0:router(config-cfm-dmn)# service Bridge_Service bridge group BD1 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 an xconnect where MIPs and up MEPs will be created. The **id** sets the short MA name.
Step 5	**maximum-meps** *number* **Example:** `RP/0/0/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.

	Command or Action	Purpose
Step 6	**log** {**ais**|**continuity-check errors**|**continuity-check mep changes**|**crosscheck errors**|**efd**} **Example:** `RP/0/0/CPU0:router(config-cfm-dmn-svc)# log continuity-check errors`	(Optional) Enables logging of certain types of events.
Step 7	**end** or **commit** **Example:** `RP/0/0/CPU0:router(config-cfm-dmn-svc)# commit`	Saves configuration changes. • 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 CFM MEPs

When you configure CFM MEPs, consider the following guidelines:

- Up to 16 MEPs are supported per interface (8 up MEPs and 8 down MEPs) or up to 15 MPs (7 up MEPs, 7 down MEPs, and 1 MIP).
- Up to 2000 maintenance points are supported per card.
- Up to 3000 maintenance points are supported per system.
- CFM maintenance points can be created on the following interface types:
  - Attachment circuit (AC) Layer 2 interfaces and Layer 3 interfaces.
  - Up MEPs can be configured on an AC interface, receiving messages to and from a pseudowire.
  - Down MEPs can be configured on an AC or L3 interface, receiving and sending messages to and from an Ethernet interface.
  - L3 interfaces can only support down MEPs.
  - MIPs are only supported on an AC interface.
  - Both up and down MEPs (and MIPs) can be configured on the same interface. They can be at the same or different levels.

Restrictions

When you configure MEPs, consider the following restrictions:

- Up MEPs are not supported on Layer 3 interfaces.
- MEPs are not supported on Layer 2 bundle interfaces or bundle member interfaces.

SUMMARY STEPS

1. **configure**
2. **interface** {**FastEthernet** | **GigabitEthernet** | **TenGigE**} *interface-path-id*
3. **ethernet cfm**
4. **mep domain** *domain-name* **service** *service-name* **mep-id** *id-number*
5. **cos** *cos*
6. **end**
   or
   commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**interface** {**FastEthernet** | **GigabitEthernet** | **TenGigE**} *interface-path-id* **Example:** `RP/0/0/CPU0:router(config)# interface gigabitethernet 0/1/0/1`	Type of Ethernet interface on which you want to create a MEP. Enter **FastEthernet**, **GigabitEthernet** or **TenGigE** and the physical interface or virtual interface. **Note** Use the **show interfaces** command to see a list of all interfaces currently configured on the router. For more information about the syntax for the router, use the question mark (**?**) online help function.
Step 3	**ethernet cfm** **Example:** `RP/0/0/CPU0:router(config-if)# ethernet cfm`	Enters interface Ethernet CFM configuration mode.
Step 4	**mep domain** *domain-name* **service** *service-name* **mep-id** *id-number* **Example:** `RP/0/0/CPU0:router(config-if-cfm)# mep domain Dm1 service Sv1 mep-id 1`	Creates a maintenance end point (MEP) on an interface and enters interface CFM MEP configuration mode.

	Command or Action	Purpose
Step 5	**cos** *cos* **Example:** `RP/0/0/CPU0:router(config-if-cfm-mep)# cos 7`	(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.
Step 6	**end** or **commit** **Example:** `RP/0/0/CPU0:router(config-if-cfm-mep)# commit`	Saves configuration changes. • 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 Y.1731 AIS

This section has the following step procedures:

- Configuring AIS in a CFM Domain Service
- Configuring AIS on a CFM Interface

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* **xconnect group** *xconnect-group-name* **p2p** *xconnect-name*
5. **ais transmission** [**interval** {**1s** | **1m**}][**cos** *cos*]
6. **log ais**

7. **end**
   or
   commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**ethernet cfm** **Example:** `RP/0/0/CPU0:router(config)# ethernet cfm`	Enters Ethernet CFM global configuration mode.
Step 3	**domain** *name* **level** *level* **Example:** `RP/0/0/CPU0:router(config-cfm)# domain D1 level 1`	Specifies the domain and domain level.
Step 4	**service** *name* **xconnect group** *xconnect-group-name* **p2p** *xconnect-name* **Example:** `RP/0/0/CPU0:router(config-cfm-dmn)# service S1 bridge group BG1 bridge-domain BD2`	Specifies the service and cross-connect group and name.
Step 5	**ais transmission** [**interval** {**1s**|**1m**}][**cos** *cos*] **Example:** `RP/0/0/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.

	Command or Action	Purpose
Step 6	**log ais** **Example:** `RP/0/0/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 7	**end** or **commit** **Example:** `RP/0/0/CPU0:router(config-sla-prof-stat-cfg)# 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 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/0/0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**interface gigabitethernet** *interface-path-id* **Example:** `RP/0/0/CPU0:router# interface gigabitethernet 0/1/0/2`	Enters interface configuration mode.
Step 3	**ethernet cfm** **Example:** `RP/0/0/CPU0:router(config)# ethernet cfm`	Enters Ethernet CFM interface configuration mode.
Step 4	**ais transmission up interval 1m cos** *cos* **Example:** `RP/0/0/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/0/0/CPU0:router(config-sla-prof-stat-cfg)# 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 EFD for a CFM Service

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

Restrictions

EFD is not supported on up MEPs. It can only be configured on down MEPs, within a particular service.

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/0/0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**ethernet cfm** **Example:** `RP/0/0/CPU0:router(config)# ethernet cfm`	Enters CFM configuration mode.
Step 3	**domain** *domain-name* **level** *level-value* **Example:** `RP/0/0/CPU0:router(config-cfm-dmn)# domain D1 level 1`	Specifies or creates the CFM domain and enters CFM domain configuration mode.
Step 4	**service** *service-name* **down-meps** **Example:** `RP/0/0/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/0/0/CPU0:router(config-cfm-dmn-svc)# efd`	Enables EFD on all down MEPs in the down MEPS service.

	Command or Action	Purpose
Step 6	**log efd** **Example:** `RP/0/0/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/0/0/CPU0:router(config-cfm-dmn-svc)# 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 the EFD Configuration

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

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

Server VLAN MA
==============
Interface         Clients
------------------------
GigE0/0/0/0.0     CFM
```

Verifying the CFM Configuration

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

Command	Purpose
show ethernet cfm configuration-errors [**domain** *domain-name*] [**interface** *interface-path-id*]	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 *name* [**service** *name*] | **interface** *type interface-path-id*] [**mep** | **mip**]	Displays a list of local maintenance points.

Troubleshooting Tips

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

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

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

Type escape sequence to abort.
Sending 5 CFM Loopbacks, timeout is 2 seconds -
Domain foo (level 2), Service foo
Source: MEP ID 1, interface GigabitEthernet0/0/0/0
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/0/0/CPU0:router# traceroute ethernet cfm domain D1 service S1 mep-id 16 source
interface gigabitethernet 0/0/0/0

Traceroutes in domain D1 (level 4), service S1
Source: MEP-ID 1, interface GigabitEthernet0/0/0/0
```

```
================================================================================
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                      0001.0203.0400 [Down]                         FDB
      0000-0001.0203.0400    Gi0/0/0/0
  2 abc                                             0001.0203.0401 [Ok]    FDB
      ios                                           Not present
  3 bcd                      0001.0203.0402 [Ok]                           Hit
      abc                    GigE0/0
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.

Configuring Ethernet SLA

This section describes how to configure Ethernet SLA.

Ethernet SLA Configuration Guidelines

Caution Certain SLA configurations can use a large amount of memory which can affect the performance of other features on the router.

Before you configure Ethernet SLA, consider the following guidelines:

- Aggregation—Use of the **aggregate none** command significantly increases the amount of memory required because each individual measurement is recorded, rather than just counts for each aggregation bin. When you configure aggregation, consider that more bins will require more memory.
- Buckets archive—When you configure the **buckets archive** command, consider that the more history that is kept, the more memory will be used.
- Measuring two statistics (such as both delay and jitter) will use approximately twice as much memory as measuring one.
- Separate statistics are stored for one-way source-to-destination and destination-to-source measurements, which consumes twice as much memory as storing a single set of round-trip statistics.
- The Cisco XR 12000 Series Router supports SLA packet of 100 ms and longer. The overall packet rates for SLA is up to 2000 CCMs-per-second sent, and up to 2000 CCMs-per-second received, per card.

The following procedure provides the steps to configure Ethernet Service Level Agreement (SLA) monitoring at Layer 2.

To configure SLA, perform the following tasks:

- Configuring an SLA Operation Profile, page 170
- Configuring SLA Probe Parameters in a Profile, page 171
- Configuring SLA Statistics Measurement in a Profile, page 173
- Configuring a Schedule for an SLA Operation Probe in a Profile, page 175
- Configuring an SLA Operation, page 177
- Configuring an On-Demand SLA Operation, page 178
- Verifying SLA Configuration, page 180

Configuring an SLA Operation Profile

To configure a profile, perform the following steps:

SUMMARY STEPS

1. **configure**
2. **ethernet sla**
3. **profile** *profile-name* **type** {**cfm-delay-measurement** | **cfm-loopback**}
4. **end**
   or
   commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure** **Example:** `RP/0/0/CPU0:router# configure`	Enters global configuration mode.
Step 2	**ethernet sla** **Example:** `RP/0/0/CPU0:router# ethernet sla`	Enters the SLA configuration mode.

	Command or Action	Purpose
Step 3	**profile** *profile-name* **type** {**cfm-delay-measurement** | **cfm-loopback**} **Example:** `RP/0/0/CPU0:router(config-sla)# profile Prof1 type cfm-loopback`	Creates an SLA operation profile and enters the SLA profile configuration mode.
Step 4	**end** or **commit** **Example:** `RP/0/0/CPU0:router(config-sla)# 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 SLA Probe Parameters in a Profile

To configure SLA probe parameters in a profile, perform the following steps beginning in SLA profile configuration mode:

SUMMARY STEPS

1. **probe**
2. **send burst** {**every** *number* {**seconds** | **minutes** | **hours**}| **once**} **packet count** *packets* **interval** *number* {**seconds** | **milliseconds**}
   or
   send packet {**every** *number* {**milliseconds** | **seconds** | **minutes** | **hours**} | **once**}
3. **packet size** *bytes* [**test pattern** {**hex 0x***HHHHHHHH* | **pseudo-random**}]
4. **priority** *priority*
5. **end**
   or
   commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	**probe** **Example:** `RP/0/0/CPU0:router(config-sla-prof)# probe`	Enters the SLA profile probe configuration mode.
Step 2	**send burst** {**every** *number* {**seconds** | **minutes** | **hours**} | **once**} **packet count** *packets* **interval** *number* {**seconds** | **milliseconds**} or **send packet** {**every** *number* {**milliseconds** | **seconds** | **minutes** | **hours**} | **once**} **Example:** `RP/0/0/CPU0:router(config-sla-prof-pb)# send burst every 60 seconds packet count 100 interval 100 milliseconds` or `RP/0/0/CPU0:router(config-sla-prof-pb)# send burst once packet count 2 interval 1 second` or `RP/0/0/CPU0:router(config-sla-prof-pb)# send packet every 100 milliseconds`	Configures the number and timing of packets sent by a probe in an operations profile.
Step 3	**packet size** *bytes* [**test pattern** {**hex 0x***HHHHHHHH* | **pseudo-random**}] **Example:** `RP/0/0/CPU0:router(config-sla-prof-pb)# packet size 9000`	(CFM loopback probe types only) Configures the minimum size (in bytes) for outgoing probe packets, including padding when necessary. Use the test pattern keyword to specify a hexadecimal string to use as the padding characters, or a pseudo-random bit sequence. The default padding is 0's.

	Command or Action	Purpose
Step 4	**priority** *priority* **Example:** `RP/0/0/CPU0:router(config-sla-prof-pb)# priority 7`	Configures the priority of outgoing SLA probe packets.
Step 5	**end** or **commit** **Example:** `RP/0/0/CPU0:router(config-sla-prof-pb)# 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 SLA Statistics Measurement in a Profile

The Ethernet SLA feature supports measurement of one-way and two-way delay and jitter statistics.

Prerequisites

To configure one-way measurements, you must first configure the **profile (SLA)** command using the **type cfm-delay-measurement** form of the command.

Restrictions

One-way delay and jitter measurements are not supported by cfm-loopback profile types.

To configure SLA statistics measurement in a profile, perform the following steps beginning in SLA profile configuration mode:

SUMMARY STEPS

1. **statistics measure** {**one-way-delay-ds** | **one-way-delay-sd** | **one-way-jitter-ds** | **one-way-jitter-sd** | **round-trip-delay** | **round-trip-jitter**}
2. **aggregate** {**bins** *count* **width** *width* | **none**}
3. **buckets size** *number* {**per-probe** | **probes**}
4. **buckets archive** *number*

5. **end**
   or
   commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	**statistics measure** {**one-way-delay-ds** | **one-way-delay-sd** | **one-way-jitter-ds** | **one-way-jitter-sd** | **round-trip-delay** | **round-trip-jitter**} **Example:** `RP/0/0/CPU0:router(config-sla-prof)# statistics measure round-trip-delay`	Enables the collection of SLA statistics, and enters SLA profile statistics configuration mode.
Step 2	**aggregate** {**bins** *count* **width** *width* | **none**} **Example:** `RP/0/0/CPU0:router(config-sla-prof-stat-cfg)# aggregate bins 100 width 10000`	Configures the size and number of bins into which to aggregate the results of statistics collection.
Step 3	**buckets size** *number* {**per-probe** | **probes}** **Example:** `RP/0/0/CPU0:router(config-sla-prof-stat-cfg)# buckets size 100 per-probe`	Configures the size of the buckets in which statistics are collected.

	Command or Action	Purpose
Step 4	**buckets archive** *number* **Example:** `RP/0/0/CPU0:router(config-sla-prof-stat-cfg)# buckets archive 50`	Configures the number of buckets to store in memory.
Step 5	**end** or **commit** **Example:** `RP/0/0/CPU0:router(config-sla-prof-stat-cfg)# 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 Schedule for an SLA Operation Probe in a Profile

This section describes how to configure a schedule for an SLA operation probe on an ongoing basis within an SLA profile. For information about how to configure a schedule for a limited, on-demand SLA operation, see the "Configuring an On-Demand SLA Operation" section on page 178.

To configure a schedule for an SLA operation probe, perform the following steps beginning in SLA profile configuration mode:

SUMMARY STEPS

1. **schedule every week on** *day* [**at** *hh*:*mm*] [**for** *duration* {**seconds** | **minutes** | **hours** | **days** | **week**}]
   or
   schedule every day [**at** *hh*:*mm*] [**for** *duration* {**seconds** | **minutes** | **hours** | **days** | **week**}]
   or
   schedule every *number* {**hours** | **minutes**}[**first at** *hh*:*mm*[**.***ss*]] [**for** *duration* {**seconds** | **minutes** | **hours** | **days** | **week**}]
2. **end**
   or
   commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	**schedule every week on** *day* [**at** *hh*:*mm*] [**for** *duration* {**seconds** | **minutes** | **hours** | **days** | **week**}] or **schedule every day** [**at** *hh*:*mm*] [**for** *duration* {**seconds** | **minutes** | **hours** | **days** | **week**}] **or** **schedule every** *number* {**hours** | **minutes**}[**first at** *hh*:*mm*[.*ss*]] [**for** *duration* {**seconds** | **minutes** | **hours** | **days** | **week**}] **Example:** `RP/0/0/CPU0:router(config-sla-prof)# schedule every week on Monday at 23:30 for 1 hour` or `RP/0/0/CPU0:router(config-sla-prof)# schedule every day at 11:30 for 5 minutes` or `RP/0/0/CPU0:router(config-sla-prof)# schedule every 2 hours first at 13:45:01` or `RP/0/0/CPU0:router(config-sla-prof)# schedule every 6 hours for 2 hours`	Schedules an operation probe in a profile. A profile may contain only one schedule.
Step 2	**end** or **commit** **Example:** `RP/0/0/CPU0:router(config-sla-prof-stat-cfg)# 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 an SLA Operation

This section describes how to configure an ongoing SLA operation on a MEP using an SLA profile.

SUMMARY STEPS

1. **interface** [**FastEthernet** | **GigabitEthernet** | **TenGigE**] *interface-path-id*
2. **ethernet cfm**
3. **mep domain** *domain-name* **service** *service-name* **mep-id** *id-number*
4. **sla operation profile** *profile-name* **target** {**mep-id** *id* | **mac-address** *mac-address*}
5.
6. **end**
   or
   commit

DETAILED STEPS

	Command or Action	Purpose
Step 1	**interface** [**FastEthernet** | **GigabitEthernet** | **TenGigE**] *interface-path-id* **Example:** `RP/0/0/CPU0:router(config-if)# interface gigabitethernet 0/1/0/1`	Physical interface or virtual interface. **Note** Use the **show interfaces** command to see a list of all interfaces currently configured on the router. For more information about the syntax for the router, use the question mark (**?**) online help function.
Step 2	**ethernet cfm** **Example:** `RP/0/0/CPU0:router(config-if)# ethernet cfm`	Enters interface CFM configuration mode.
Step 3	**mep domain** *domain-name* **service** *service-name* **mep-id** *id-number* **Example:** `RP/0/0/CPU0:router(config-if-cfm)# mep domain Dm1 service Sv1 mep-id 1`	Creates a MEP on an interface and enters interface CFM MEP configuration mode.

	Command or Action	Purpose
Step 4	**sla operation profile** *profile-name* **target** {**mep-id** *id* | **mac-address** *mac-address*} **Example:** `RP/0/0/CPU0:router(config-if-cfm-mep)# sla operation profile Profile_1 target mac-address 01:23:45:67:89:ab`	Creates an operation instance from a MEP to a specified destination.
Step 5	**end** or **commit** **Example:** `RP/0/0/CPU0:router(config-sla-prof-stat-cfg)# 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 an On-Demand SLA Operation

You can configure an on-demand SLA operation to run on an as-needed basis for a finite period of time.

This section includes the following topics:

Configuration Guidelines

When you configure on-demand SLA operations, consider the following guidelines:

- Each MEP supports up to 50 on-demand operations.
- Each card supports up to 250 on-demand operations.
- On-demand Ethernet SLA operations can be run in addition to any other ongoing scheduled SLA operations that you might have configured, and use similar amounts of CPU and router memory. When configuring an on-demand Ethernet SLA operation, you should consider your existing SLA operation configuration and the potential impact of additional packet processing to your normal operations.

- If you do not specify a schedule for the on-demand operation, the probe defaults to running one time beginning two seconds from the execution of the command, and runs for a ten-second duration.
- If you do not specify the statistics for the probe to measure, it defaults to measuring all statistics, inlcuding the following statistics by probe type:
  - CFM loopback—Two-way delay and jitter is measured by default.
  - CFM delay measurement—One-way delay and jitter in both directions, in addition to two-way delay and jitter is measured by default.
- The default operation mode is synchronous, where progress of the operation is reported to the console and the output of the statistics collection is displayed.

Configuring an On-Demand Ethernet SLA Operation for CFM Delay Measurement

To configure an on-demand Ethernet SLA operation for CFM delay measurement, use the following command in privileged EXEC configuration mode:

Command	Purpose
ethernet sla on-demand operation type cfm-delay-measurement probe [**priority** *number*] [**send** {**packet** {**once** | **every** *number* {**milliseconds** | **seconds** | **minutes** | **hours**}} | **burst** {**once** | **every** *number* {**seconds** | **minutes** | **hours**}} **packet count** *number* **interval** *number* {**milliseconds** | **seconds**}] **domain** *domain-name* **source interface** *type interface-path-id* **target** {**mac-address** *H.H.H.H* | **mep-id** *id-number*} [**statistics measure** {**one-way-delay-ds** | **one-way-delay-sd** | **one-way-jitter-ds** | **one-way-jitter-sd** | **round-trip-delay** | **round-trip-jitter**}][**aggregate** {**none** | **bins** *number* **width** *milliseconds*}] [**buckets** {**archive** *number* | **size** *number* {**per-probe** | **probes**}}] [**schedule** {**now** | **at** *hh***:***mm*[**.***ss*] [*day* [*month* [*year*]]] | **in** *number* {**seconds** | **minutes** | **hours**}}[**for** *duration* {**seconds** | **minutes** | **hours**}][**repeat every** *number* {**seconds** | **minutes** | **hours**} **count** *probes*]] [**asynchronous**] **Example:** `RP/0/0/CPU0:router# ethernet sla on-demand operation type cfm-delay-measurement probe domain D1 source interface TenGigE 0/6/1/0 target mep-id 100`	Configures an on-demand Ethernet SLA operation for CFM delay measurement. The example shows a minimum configuration, that specifies the local domain and source interface and target MEP, using the following defaults: • Send a burst once for a packet count of 10 and interval of 1 second (10-second probe). • Use default class of service (CoS) for the egress interface. • Measure all statistics, including both one-way and round-trip delay and jitter statistics. • Aggregate statistics into one bin. • Schedule now. • Display results on the console.

Configuring an On-Demand Ethernet SLA Operation for CFM Loopback

To configure an on-demand Ethernet SLA operation for CFM loopback, use the following command in privileged EXEC configuration mode:

Command	Purpose
ethernet sla on-demand operation type cfm-loopback probe [**packet size** *bytes* [**test pattern** {**hex 0x***HHHHHHHH* | **pseudo-random**}]] [**priority** *number*] [**send** {**packet** {**once** | **every** *number* {**milliseconds** | **seconds** | **minutes** | **hours**}} | **burst** {**once** | **every** *number* {**seconds** | **minutes** | **hours**}} **packet count** *number* **interval** *number* {**milliseconds** | **seconds**}] **domain** *domain-name* **source interface** *type interface-path-id* **target** {**mac-address** *H.H.H.H* | **mep-id** *id-number*} [**statistics measure** {**round-trip-delay** | **round-trip-jitter**}][**aggregate** {**none** | **bins** *number* **width** *milliseconds*}][**buckets** {**archive** *number* | **size** *number* {**per-probe** | **probes**}}] [**schedule** {**now** | **at** *hh*:*mm*[.*ss*] [*day* [*month* [*year*]]] | **in** *number* {**seconds** | **minutes** | **hours**}}[**for** *duration* {**seconds** | **minutes** | **hours**}][**repeat every** *number* {**seconds** | **minutes** | **hours**} **count** *probes*]] [**asynchronous**] **Example:** `RP/0/0/CPU0:router# ethernet sla on-demand operation type cfm-loopback probe packet size 1500 domain D1 source interface TenGigE 0/6/1/0 target mep-id 100`	Configures an on-demand Ethernet SLA operation for CFM loopback. The example shows a minimum configuration, but specifies the option of a minimum packet size, and specifies the local domain and source interface and target MEP, using the following defaults: • Send a burst once for a packet count of 10 and interval of 1 second (10-second probe). • Use default test pattern of 0's for padding. • Use default class of service (CoS) for the egress interface. • Measure all statistics. • Aggregate statistics into one bin. • Schedule now. • Display results on the console.

Verifying SLA Configuration

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

Command	Purpose
show ethernet sla configuration-errors [**domain** *domain-name*] [**interface** *interface-path-id*] [**profile** *profile-name*]	Displays information about errors that are preventing configured SLA operations from becoming active, as well as any warnings that have occurred.
show ethernet sla operations [**detail**] [**domain** *domain-name*] [**interface** *interface-path-id*] [**profile** *profile-name*]	Displays information about configured SLA operations.

–

Configuration Examples for Ethernet OAM

This section provides the following configuration examples:

Configuration Examples for EOAM Interfaces

This section provides the following configuration examples:

Configuring an Ethernet OAM Profile Globally: Example

The following example shows how to configure an Ethernet OAM profile globally:

```
configure terminal
 ethernet oam profile Profile_1
  link-monitor
   frame window 60
   frame threshold low 10000000 high 60000000
   frame-period window 60000
   frame-period threshold low 100 high 12000000
   frame-seconds window 900000
   frame-seconds threshold 3 threshold 900
   exit
  mib-retrieval
  connection timeout 30
  require-remote mode active
  require-remote link-monitoring
  require-remote mib-retrieval
  action dying-gasp error-disable-interface
  action critical-event error-disable-interface
  action discovery-timeout error-disable-interface
  action session-down error-disable-interface
  action capabilities-conflict error-disable-interface
  action wiring-conflict error-disable-interface
  action remote-loopback error-disable-interface
  commit
```

Configuring Ethernet OAM Features on an Individual Interface: Example

The following example shows how to configure Ethernet OAM features on an individual interface:

```
configure terminal
 interface TenGigE 0/1/0/0
  ethernet oam
```

```
   link-monitor
    frame window 60
    frame threshold low 10000000 high 60000000
    frame-period window 60000
    frame-period threshold low 100 high 12000000
    frame-seconds window 900000
    frame-seconds threshold 3 threshold 900
    exit
   mib-retrieval
   connection timeout 30
   require-remote mode active
   require-remote link-monitoring
   require-remote mib-retrieval
   action link-fault  error-disable-interface
   action dying-gasp error-disable-interface
   action critical-event error-disable-interface
   action discovery-timeout error-disable-interface
   action session-down error-disable-interface
   action capabilities-conflict error-disable-interface
   action wiring-conflict error-disable-interface
   action remote-loopback error-disable-interface
   commit
```

Configuring Ethernet OAM Features to Override the Profile on an Individual Interface: Example

The following example shows the configuration of Ethernet OAM features in a profile followed by an override of that configuration on an interface:

```
configure terminal
 ethernet oam profile Profile_1
  mode passive
  action dying-gasp disable
  action critical-event disable
  action discovery-timeout disable
  action session-up disable
  action session-down disable
  action capabilities-conflict disable
  action wiring-conflict disable
  action remote-loopback disable
  action uni-directional link-fault error-disable-interface
  commit

configure terminal
 interface TenGigE 0/1/0/0
  ethernet oam
   profile Profile_1
    mode active
    action dying-gasp log
    action critical-event log
    action discovery-timeout log
    action session-up log
    action session-down log
    action capabilities-conflict log
    action wiring-conflict log
    action remote-loopback log
    action uni-directional link-fault log
    uni-directional link-fault detection
    commit
```

Clearing Ethernet OAM Statistics on an Interface: Example

The following example shows how to clear Ethernet OAM statistics on an interface:

```
RP/0/RP0/CPU0:router# clear ethernet oam statistics interface gigabitethernet 0/1/5/1
```

Enabling SNMP Server Traps on a Router: Example

The following example shows how to enable SNMP server traps on a router:

```
configure terminal
  ethernet oam profile Profile_1
  snmp-server traps ethernet oam events
```

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

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

```
  service Cross_Connect_1 xconnect group XG1 p2p X1
  commit
```

Continuity Check for an Ethernet CFM Service Configuration: Example

The following 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

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

```
mip auto-create all
commit
```

Cross-check for an Ethernet CFM Service Configuration: Example

The following 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

The following example shows how to configure other Ethernet CFM service options:

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

MEP Configuration: Example

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

```
interface gigabitethernet 0/1/0/1
 ethernet cfm
 mep domain Dm1 service Sv1 mep-id 1
 commit
```

Ethernet CFM Show Command: Examples

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

Example 1

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

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

Domain/Level         Service             Interface         Type    ID   MAC
```

```
-------------------- ------------------- ----------------- ------ ---- --------
fig/5                bay                 Gi0/10/0/12.23456 Dn MEP    2 44:55:66
fig/5                bay                 Gi0/0/1/0.1       MIP         55:66:77
fred/3               barney              Gi0/1/0/0.1       Up MEP    5 66:77:88!
```

Example 2

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

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

Domain fig (level 5), Service bay
 * An Up MEP is configured for this domain on interface GigabitEthernet0/1/2/3.234 and an
Up MEP is also configured for domain blort, which is at the same level (5).
 * A MEP is configured on interface GigabitEthernet0/3/2/1.1 for this domain/service,
which has CC interval 100ms, but the lowest interval supported on that interface is 1s
```

Example 3

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

```
RP/0/0/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 Gi1/1/0/1.234 (Up)       Up     0/0   N  A

Domain fred (level 5), Service barney
   ID Interface (State)        Dir MEPs/Err RD Defects AIS
----- ----------------------- --- -------- -- ------- ---
    2 Gi0/1/0/0.234 (Up)       Up     3/2   Y  RPC
```

Example 4

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

```
RP/0/0/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
Up MEP on GigabitEthernet0/1/0/0.234, 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
U>     7 6677.8899.0011 Up      00:02             456      0     0     0

Domain fred (level 7), Service fig
Down MEP on GigabitEthernet0/10/0/12.123, 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

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

```
RP/0/0/CPU0:router# show ethernet cfm peer meps detail
Domain dom3 (level 5), Service ser3
Down MEP on GigabitEthernet0/0/0/0 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 GigabitEthernet0/0/0/0 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
```

AIS for CFM Configuration: Examples

Example 1

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

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

Example 2

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

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

```
RP/0/0/CPU0:router# configure
RP/0/0/CPU0:router(config)# interface gigabitethernet 0/1/0/2
RP/0/0/CPU0:router(config-if)# ethernet cfm
RP/0/0RP0RSP0/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, page 188
- show ethernet cfm local meps Command: Examples, page 188

show ethernet cfm interfaces ais Command: Example

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

```
RP/0/0/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

                                 Trigger                  Transmission
                        AIS      ---------    Via    ---------------------------
Interface (State)       Dir   L Defects  Levels   L Int Last started  Packets
----------------------- ---   - -------  -------  - --- ------------ --------
Gi0/1/0/0.234 (Up)      Dn    5 RPC      6        7 1s  01:32:56 ago     5576
Gi0/1/0/0.567 (Up)      Up    0 M        2,3      5 1s  00:16:23 ago      983
Gi0/1/0/1.1 (Dn)        Up      D                7 60s 01:02:44 ago     3764
Gi0/1/0/2 (Up)          Dn    0 RX       1!
```

show ethernet cfm local meps Command: Examples

Example 1: Default

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

```
RP/0/0/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 Gi1/1/0/1.234 (Up)       Up     0/0   N  A       7

Domain fred (level 5), Service barney
   ID Interface (State)        Dir MEPs/Err RD Defects AIS
----- ----------------------- --- -------- -- ------- ---
    2 Gi0/1/0/0.234 (Up)       Up     3/2   Y  RPC     6
```

Example 2: Domain Service

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

```
RP/0/RSP0RP0/CPU0:router# show ethernet cfm local meps domain foo service bar detail

Domain foo (level 6), Service bar
Up MEP on GigabitEthernet0/1/0/0.234, 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
Up MEP on GigabitEthernet0/1/0/0.234, 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 3: Verbose

The following example shows how to display verbose statistics for MEPs in a domain service:

Note The Discarded CCMs field is not displayed when the number is zero (0). It is unusual for the count of discarded CCMs to be any thing other than zero, since CCMs are only discarded when the limit on the number of peer MEPs is reached.

```
RP/0/RSP0RP0/CPU0:router# show ethernet cfm local meps domain foo service bar verbose

Domain foo (level 6), Service bar
Up MEP on GigabitEthernet0/1/0/0.234, 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)

  Packet        Sent      Received
  ------  ----------  ----------------------------------------------------
  CCM             0             0  (out of seq: 0)
  LBM             0             0
  LBR             0             0  (out of seq: 0, with bad data: 0)
  AIS          5576             0
  LCK             -             0

Domain fred (level 5), Service barney
Up MEP on GigabitEthernet0/1/0/0.234, 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
```

```
Packet         Sent      Received
------  -----------  ------------------------------------------------------------
CCM          12345         67890  (out of seq: 6, discarded: 10)
LBM              5             0
LBR              0             5  (out of seq: 0, with bad data: 0)
AIS              0         46910
LCK              -             0
```

Example 4: Detail

The following example shows how to display detailed statistics for MEPs in a domain service:

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

Domain foo (level 6), Service bar
Up MEP on GigabitEthernet0/1/0/0.234, 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
Up MEP on GigabitEthernet0/1/0/0.234, 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
```

EFD Configuration: Examples

The following example shows how to enable EFD:

```
RP/0/0/CPU0:router# configure
RP/0/0/CPU0:router(config)# ethernet cfm
RP/0/0/CPU0:router(config-cfm)# domain D1 level 1
RP/0/0/CPU0:router(config-cfm-dmn)# service S1 down-meps
RP/0/0/CPU0:router(config-cfm-dmn-svc)# efd
```

The following example shows how to enable EFD logging:

```
RP/0/0/CPU0:router# configure
RP/0/0/CPU0:router(config)# ethernet cfm
RP/0/0/CPU0:router(config-cfm)# domain D1 level 1
RP/0/0/CPU0:router(config-cfm-dmn)# service S1 down-meps
RP/0/0/CPU0:router(config-cfm-dmn-svc)# log efd
```

Displaying EFD Information: Examples

The following examples show how to display information about EFD:

- show efd interfaces Command: Example, page 192
- show ethernet cfm local meps detail Command: Example, page 192

show efd interfaces Command: Example

The following example shows how to display all interfaces that are shut down in response to an EFD action:

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

Server VLAN MA
==============
Interface         Clients
------------------------
GigE0/0/0/0.0     CFM
```

show ethernet cfm local meps detail Command: Example

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

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

Domain foo (level 6), Service bar
Up MEP on GigabitEthernet0/1/0/0.234, 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
Up MEP on GigabitEthernet0/1/0/0.234, 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*.

Configuration Examples for Ethernet SLA

This section includes the following examples:

Ethernet SLA Profile Type Configuration: Examples

The following examples show how to configure the different profile types supported by Ethernet SLA.

Example 1

This example configures a profile named “Prof1” for CFM loopback measurements:

```
configure
 ethernet sla
  profile  Prof1 type cfm-loopback
   commit
```

Example 2

This example configures a profile named “Prof1” for CFM delay measurements. Setting this type allows you to configure the probe to measure additional one-way delay and jitter statistics:

```
configure
 ethernet sla
  profile  Prof1 type cfm-delay-measurement
   commit
```

Ethernet SLA Probe Configuration: Examples

The following examples show how to configure some of the packet options for an Ethernet CFM loopback probe.

Example 1

This example shows how to configure sending a group of 100 packets in 100 ms intervals and repeat that burst every 60 seconds. Packets are padded to a size of 9000 bytes as needed using a hexadecimal test pattern of “abcdabcd,” and with a class of service value of 7:

Note The total length of a burst (packet count multiplied by the interval) must not exceed 1 minute.

```
configure
 ethernet sla
  profile  Prof1 type cfm-loopback
   probe
    send burst every 60 seconds packet count 100 interval 100 milliseconds
    packet size 9000 test pattern hex 0xabcdabcd
    priority 7
    commit
```

Example 2

This example has the same characteristics as the configuration in Example 1, but sends a single burst of 50 packets, one second apart:

```
configure
 ethernet sla
  profile  Prof1 type cfm-loopback
   probe
    send burst once packet count 50 interval 1 second
    packet size 9000 test pattern hex 0xabcdabcd
    priority 7
    commit
```

Example 3

This example shows how to configure a continuous stream of packets at 100 ms intervals for the duration of the probe. Packets are padded to a size of 9000 bytes as needed using a pseudo-random test pattern, and with a class of service value of 7:

```
configure
 ethernet sla
  profile Prof1 type cfm-loopback
   probe
    send burst every 60 seconds packet count 600 interval 100 milliseconds
    packet size 9000 test pattern pseudo-random
    priority 7
    commit
```

Profile Statistics Measurement Configuration: Examples

The following examples show how to configure the different types of statistics measurement.

Example 1

This example shows the two available types of statistics that can be measured by a CFM loopback SLA profile type:

```
configure
 ethernet sla
  profile  Prof1 type cfm-loopback
  statistics measure round-trip-delay
  statistics measure round-trip-jitter
   commit
```

Example 2

This example shows how to configure measurement of round-trip delay and one-way jitter (from destination to source) for a CFM delay measurement SLA profile type:

Note The CFM delay measurement profile type supports measurement of all round-trip and one-way delay and jitter statistics.

```
configure
 ethernet sla
  profile  Prof1 type cfm-delay-measurement
  statistics measure round-trip-delay
  statistics measure one-way-jitter-ds
   commit
```

Scheduled SLA Operation Probe Configuration: Examples

The following examples show how to configure different schedules for an SLA operation probe.

Example 1

This example shows how to configure a probe to run hourly for a specified duration:

```
configure
 ethernet sla
  profile  Prof1 type cfm-delay-measurement
  schedule every 1 hours for 15 minutes
  commit
```

Example 2

This example shows how to configure a probe to run daily for a specified period of time:

```
configure
 ethernet sla
  profile  Prof1 type cfm-delay-measurement
  schedule every day at 11:30 for 5 minutes
  commit
```

Example 3

This example shows how to configure a probe to run weekly beginning at a specified time and for a specified duration:

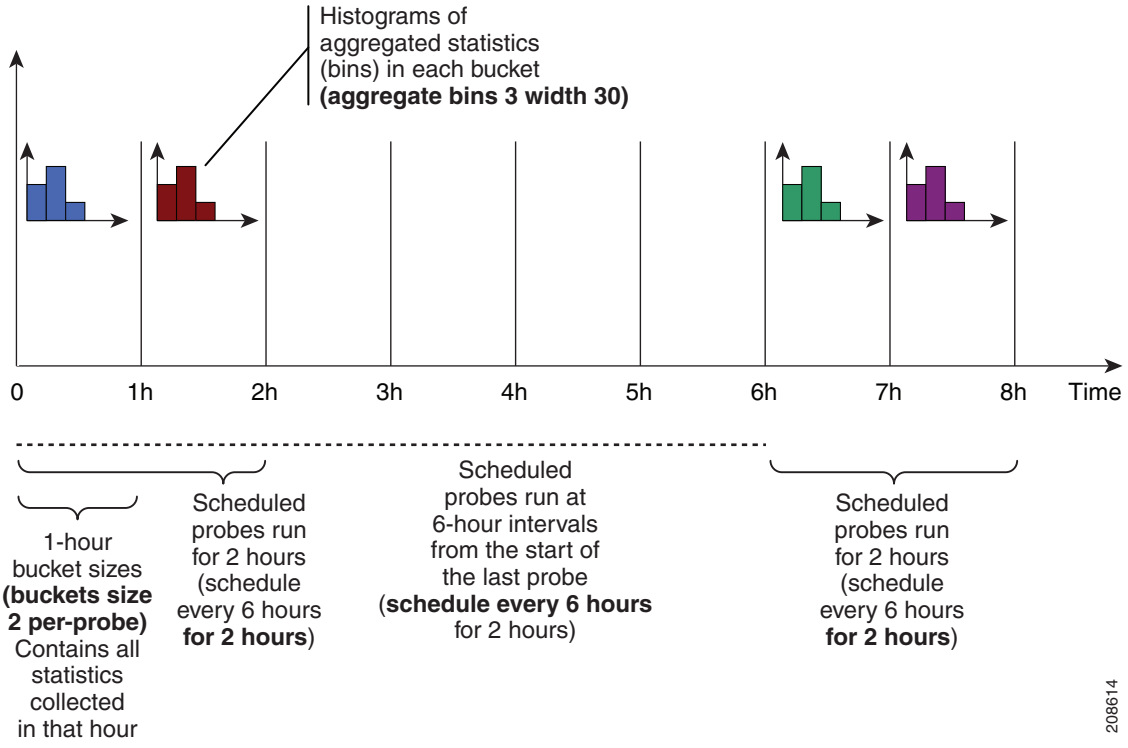
```
configure
 ethernet sla
  profile  Prof1 type cfm-delay-measurement
  schedule every week on Monday at 23:30 for 1 hour
  commit
```

Ethernet SLA Operation Probe Scheduling and Aggregation Configuration: Example

Figure 12 shows a more comprehensive example of how some of the probe scheduling and measurement configuration works using aggregation. The following configuration supports some of the concepts shown in the figure:

```
configure
 ethernet sla profile Prof1 type cfm-loopback
  probe
   send packet every 60 seconds
   schedule every 6 hours for 2 hours
   statistics measure round-trip-delay
    aggregate bins 3 width 30
    buckets size 2 per-probe
    buckets archive 4
    commit
```

Figure 12 SLA Probe Scheduling Operation With Bin Aggregation



This example schedules a probe with the following characteristics:

- Sends packets 60 seconds apart (for a 2-hour probe, this results in sending 120 individual packets).
- Probe runs every 6 hours for 2 hours duration.
- Collects data into 2 buckets for every probe, so each bucket covers 1 hour of the 2-hour probe duration.
- Aggregates statistics within the buckets into 3 bins each in the following ranges:
  - Bin 1 contains samples in the range 0 to < 30 ms.
  - Bin 2 contains samples in the range 30 ms to < 60 ms.
  - Bin 3 contains samples in the range 60 ms or greater (unbounded).
- The last 4 buckets are saved in memory.

Ongoing Ethernet SLA Operation Configuration: Example

The following example shows how to configure an ongoing Ethernet SLA operation on a MEP:

```
interface gigabitethernet 0/1/0/1
 ethernet cfm
 mep domain Dm1 service Sv1 mep-id 1
 sla operation profile Profile_1 target mac-address 01:23:45:67:89:ab s
 commit
 end
```

On-Demand Ethernet SLA Operation Basic Configuration: Examples

The following examples show how to configure on-demand Ethernet SLA operations.

Example 1

The following example shows how to configure a basic on-demand Ethernet SLA operation for a CFM loopback probe that by default will measure round-trip delay and round-trip jitter for a one-time, 10-second operation to the target MEP:

```
RP/0/0/CPU0:router# ethernet sla on-demand operation type cfm-loopback probe domain D1
source interface TenGigE 0/6/1/0 target mep-id 1
```

Example 2

The following example shows how to configure a basic on-demand Ethernet SLA operation for a CFM delay measurement probe that by default will measure one-way delay and jitter in both directions, as well as round-trip delay and round-trip jitter for a one-time, 10-second operation to the target MEP:

```
RP/0/0/CPU0:router# ethernet sla on-demand operation type cfm-delay-measurement probe
domain D1 source interface TenGigE 0/6/1/0 target mep-id 1
```

Ethernet SLA Show Commands: Examples

The following examples show how to display information about configured SLA operations:

show ethernet sla operations Command: Example 1

```
RP/0/0/CPU0:router# show ethernet sla operations interface gigabitethernet 0/1/0/1.1

Interface GigabitEthernet0/1/0/1.1
Domain mydom Service myser to 00AB.CDEF.1234
--------------------------------------------------------------------------------
Profile 'business-gold'
Probe type CFM-delay-measurement:
    bursts sent every 1min, each of 20 packets sent every 100ms
    packets padded to 1500 bytes with zeroes
    packets use priority value of 7
Measures RTT: 5 bins 20ms wide; 2 buckets/ probe; 75/100 archived
Measures Jitter (interval 1): 3 bins 40ms wide; 2 buckets/probe; 50 archived
Scheduled to run every Sunday at 4am for 2 hours:
    last run at 04:00 25/05/2008
```

show ethernet sla configuration-errors Command: Example 2

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

Errors:
-------
  Profile 'gold' is not defined but is used on Gi0/0/0/0.0
  Profile 'red' defines a test-pattern, which is not supported by the type
```

The following examples show how to display the contents of buckets containing SLA metrics collected by probes:

show ethernet sla statistics current Command: Example 3

```
RP/0/0/CPU0:router# show ethernet sla statistics current interface GigabitEthernet
0/0/0/0.0

Interface GigabitEthernet 0/0/0/0.0
Domain mydom Service myser to 00AB.CDEF.1234
```

```
================================================================================
Profile 'business-gold', packet type 'cfm-loopback'
Scheduled to run every Sunday at 4am for 2 hours

Round Trip Delay
~~~~~~~~~~~~~~~~
2 buckets per probe

Bucket started at 04:00 Sun 17 Feb 2008 lasting 1 hour:
    Pkts sent: 2342; Lost 2 (0%); Corrupt: 0 (0%); Misordered: 0 (0%)
    Min: 13ms; Max: 154ms; Mean: 28ms; StdDev: 11ms

Round Trip Jitter
~~~~~~~~~~~~~~~~~
2 buckets per probe

Bucket started at 04:00 Sun 17 Feb 2008 lasting 1 hour:
    Pkts sent: 2342; Lost: 2 (0%); Corrupt: 0 (0%); Misordered: 0 (0%)
    Min: -5ms; Max: 8ms; Mean: 0ms; StdDev: 3.6ms

Bucket started at 05:00 Sun 17 Feb 2008 lasting 1 hour:
    Pkts sent: 2342; Lost: 2 (0%); Corrupt: 0 (0%); Misordered: 0 (0%)
    Min: 0; Max: 4; Mean: 1.4; StdDev: 1
```

show ethernet sla statistics history detail Command: Example 4

```
RP/0/0/CPU0:router# show ethernet sla history detail GigabitEthernet 0/0/0/0.0

Interface GigabitEthernet 0/0/0/0.0
Domain mydom Service myser to 00AB.CDEF.1234
================================================================================
Profile 'business-gold', packet type 'cfm-loopback'
Scheduled to run every Sunday at 4am for 2 hours

Round Trip Delay
~~~~~~~~~~~~~~~~
2 buckets per probe

Bucket started at 04:00 Sun 17 Feb 2008 lasting 1 hour:
    Pkts sent: 2342; Lost: 2 (0%); Corrupt: 0 (0%); Misordered: 0 (0%)
    Min: 13ms, occurred at 04:43:29 on Sun 22 Aug 2010 UTC
    Max: 154ms, occurred at 05:10:32 on Sun 22 Aug 2010 UTC
    Mean: 28ms; StdDev: 11ms

    Results suspect as more than 10 seconds time drift detected
    Results suspect as scheduling latency prevented some packets being sent

    Samples:
    Time sent       Result  Notes
    ------------  --------  ----------
    04:00:01.324      23ms
    04:00:01.425      36ms
    04:00:01.525         -  Timed Out
    ...

Round Trip Jitter
~~~~~~~~~~~~~~~~~
2 buckets per probe

Bucket started at 04:00 Sun 17 Feb 2008, lasting 1 hour:
    Pkts sent: 2342; Lost: 2 (0%); Corrupt: 0 (0%); Misordered: 0 (0%)
    Min: -5ms; Max: 10ms; Mean: 0ms; StdDev: 3.6ms

    Samples:
```

```
    Time sent       Result  Notes
    ------------  --------  ----------
    04:00:01.324         -
    04:00:01.425      13ms
    04:00:01.525         -  Timed out
    ...
```

show ethernet sla statistics history detail on-demand: Example 5

The following example shows how to display statistics for all full buckets for on-demand operations in detail:

```
RP/0/0/CPU0/router #show ethernet sla statistics history detail on-demand

Interface GigabitEthernet0/0/0/0.1
Domain mydom Service myser to 0123.4567.890A
------------------------------------------------------------------------------
On-demand operation ID #1, packet type 'cfm-delay-measurement'
Started at 15:38 on 06 July 2010 UTC, runs every 1 hour for 1 hour

Round Trip Delay
~~~~~~~~~~~~~~~~
1 bucket per probe

Bucket started at 15:38 on Tue 06 Jul 2010 UTC, lasting 1 hour:
    Pkts sent: 1200; Lost: 4 (0%); Corrupt: 600 (50%); Misordered: 0 (0%)
    Min: 13ms, occurred at 15:43:29 on Tue 06 Jul 2010 UTC
    Max: 154ms, occurred at 16:15:34 on Tue 06 Jul 2010 UTC
    Mean: 28ms; StdDev: 11ms

    Bins:
    Range              Samples    Cum. Count      Mean
    ------------  ------------  ------------  --------
     0 - 20 ms       194 (16%)     194 (16%)      17ms
    20 - 40 ms       735 (61%)     929 (77%)      27ms
    40 - 60 ms       212 (18%)    1141 (95%)      45ms
    > 60    ms        55  (5%)    1196            70ms

Bucket started at 16:38 on Tue 01 Jul 2008 UTC, lasting 1 hour:
    Pkts sent: 3600; Lost: 12 (0%); Corrupt: 1800 (50%); Misordered: 0 (0%)
    Min: 19ms, occurred at 17:04:08 on Tue 06 Jul 2010 UTC
    Max: 70ms, occurred at 16:38:00 on Tue 06 Jul 2010 UTC
    Mean: 28ms; StdDev: 11ms

    Bins:
    Range              Samples    Cum. Count      Mean
    ------------  ------------  ------------  --------
     0 - 20 ms       194 (16%)     194 (16%)      19ms
    20 - 40 ms       735 (61%)     929 (77%)      27ms
    40 - 60 ms       212 (18%)    1141 (95%)      45ms
    > 60    ms        55  (5%)    1196            64ms
```

Where to Go Next

When you have configured an Ethernet interface, you can configure individual VLAN subinterfaces on that Ethernet interface.

For information about modifying Ethernet management interfaces for the shelf controller (SC), route processor (RP), and distributed RP, see the "Advanced Configuration and Modification of the Management Ethernet Interface on Cisco IOS XR Software" module later in this document.

For information about IPv6 see the *Implementing Access Lists and Prefix Lists on Cisco IOS XR Software* module in the *Cisco IOS XR IP Addresses and Services Configuration Guide.*

Additional References

These sections provide references related to implementing Gigabit, 10-Gigabit, and Fast Ethernet interfaces.

Related Documents

Related Topic	Document Title
Cisco IOS XR master command reference	*Cisco IOS XR Master Commands List*
Cisco IOS XR interface configuration commands	*Cisco IOS XR Interface and Hardware Component Command Reference*
Information about user groups and task IDs	*Cisco IOS XR Interface and Hardware Component Command Reference*

Standards

Standards	Title
IEEE 802.1ag	*Connectivity Fault Management*
ITU-T Y.1731	*OAM Functions and Mechansims for Ethernet Based Networks*
MEF 16	*Metro Ethernet Forum, Technical Specification MEF 16, Ethernet Local Management Interface (E-LMI), January 2006*

MIBs

MIBs	MIBs Link
IEEE8021-CFM-MIB	To locate and download MIBs for selected platforms using Cisco IOS XR Software, use the Cisco MIB Locator found at the following URL: http://www.cisco.com/go/mibs

RFCs

RFCs	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	—

Technical Assistance

Description	Link
The Cisco Technical Support website contains thousands of pages of searchable technical content, including links to products, technologies, solutions, technical tips, and tools. Registered Cisco.com users can log in from this page to access even more content.	http://www.cisco.com/support