CHAPTER 19

Ethernet OAM

This chapter describes the level of support that Cisco ANA provides for Ethernet Operations, Administration, and Management (OAM), as follows:

Technology Description

This section provides the following Ethernet OAM technology descriptions:

Please see Part 1: Cisco VNEs in this guide for information about which devices support the various technologies.

CFM

Ethernet Connectivity Fault Management (CFM) is an end-to-end, per-service-instance Ethernet layer operations, administration, and maintenance (OAM) protocol. It includes proactive connectivity monitoring, fault verification, and fault isolation for large Ethernet MANs and WANs. “End-to-end” can mean PE-to-PE or CE-to-CE. A service can be identified as a service provider VLAN (S-VLAN) or an Ethernet Virtual Connection (EVC) service. Cisco ANA supports both

Cisco Proprietary Draft 1 (CFM D1) and Ethernet CFM IEEE 802.1ag Standard, using a a common IMO model.

Link OAM

Link OAM allows network operators to monitor and troubleshoot a single Ethernet link. It is an optional sublayer implemented in the Data Link Layer between the Logical Link Control (LLC) and MAC sublayers of the Open Systems Interconnect (OSI) model. You can monitor a link for critical events and, if needed, put a remote device into loopback mode for link testing. Link OAM also discovers unidirectional links, which are created when one transmission direction fails.

OAM information is conveyed in Slow Protocol frames (see Annex 57A) called OAM Protocol Data Units (OAMPDUs). OAMPDUs contain the appropriate control and status information used to monitor, test and troubleshoot OAM-enabled links. OAMPDUs traverse a single link, being passed between peer OAM entities, and as such, are not forwarded by MAC clients (e.g., bridges or switches).

Ethernet LMI

Ethernet Local Management Interface (Ethernet LMI) is a protocol that runs on the Provider Edge (PE) to Customer Edge (CE) UNI link and notifies the CE of connectivity status and configuration parameters of Ethernet services available on the CE port. Ethernet LMI interoperates with an OAM protocol, such as CFM, that runs within the provider network to collect OAM status.

Ethernet LMI provides information that enables autoconfiguration of customer edge (CE) devices and provides the status of Ethernet virtual connections (EVCs) for large Ethernet metropolitan-area networks (MANs) and WANs. Specifically, Ethernet LMI notifies a CE device of the operating state of an EVC and the time when an EVC is added or deleted. Ethernet LMI also communicates the attributes of an EVC and a user-network interface (UNI) to a CE device.

Information Model Objects (IMOs)

This section describes the following IMOs:

- CFM Service (ICfmService)
- CFM Maintenance Domain (IMaintenanceDomain)
- CFM Maintenance Point (IMaintenancePoint)
- CFM Maintenance Endpoints (IMaintenanceEndPoints)
- CFM Maintenance Association (IMaintenanceAssociation)
- CFM Maintenance Intermediate Point (IMaintenanceIntermediatePoint)
- OAM Data (IOAMData)
- OAM Remote Data (IOAMRemoteData)
- UNI Properties (IUNIProperties)
- Ethernet LMI (IEthernetLMI)
- Device EVC (IDeviceEVC)
- UNI Interfaces (IUNIInterfaces)
- ELMI Interfaces (IELMIInterfaces)

CFM Service

The CFM Service object represents an instance of CFM enabled on a device.

Table 19-1 CFM Service (ICfmService)

Attribute Name	Attribute Description	Scheme	Polling Interval
cacheSize	The CFM traceroute cache size used by the CFM service.	IP Core, Product	Configuration
maximumCacheSize	The CFM traceroute maximum cache size used by the CFM service.	IP Core, Product	Configuration
holdTime	The configured hold-time value used to indicate to the receiver the validity of traceroute and loopback messages transmitted by this device. The default is 2.5 times the transmit interval.	IP Core, Product	Configuration
version	The CFM version running on the device.	IP Core, Product	Configuration
maintenanceIntermedatePointsTable	An array of all the CFM Maintenance Intermediate Point objects configured on the device.	IP Core, Product	Configuration
maintenanceDomain	The CFM Maintenance Domain configured on the device.	IP Core, Product	Configuration

CFM Maintenance Domain

The CFM Maintenance Domain object represents an instance of a CFM management space used to manage and administer a network. A CFM management domain is owned and operated by a single entity and defined by the set of ports internal to it and at its boundary.

Table 19-2 CFM Maintenance Domain (IMaintenanceDomain)

Attribute Name	Attribute Description	Scheme	Polling Interval
name	The name of the management domain. This must be unique and cannot be used within a different maintenance level.	IP Core, Product	Configuration
level	The domain level (an integer in the range *0* to *7*). Domain levels permit creation of a domain hierarchy. The larger the level value, the larger the domain. For instance, the costumer domain will have a level of 7, and the operator domain will have a level of 0.	IP Core, Product	Configuration
Id	The domain ID. Optional and may not be defined. When undefined, the domain name is used as the default value.	IP Core, Product	Configuration
maintenanceAssociation	A list of the domain's CFM Maintenance Associations. These are the associations represented by the service. In Cisco devices, the domain is mapped to a VLAN.	IP Core, Product	Configuration

CFM Maintenance Point

The CFM Maintenance Point object represents an instance of a CFM maintenance point configured on one or more of a device's interfaces.

Table 19-3 CFM Maintenance Point (IMaintenancePoint)

Attribute Name	Attribute Description	Scheme	Polling Interval
macAddress	The MAC address on the interface on which the maintenance point is configured. In different interface modes, the MAC address may hold different values. For example, an inward facing interface uses the Bridge-Brain MAC address; an outward facing interface, such as a routed port, uses the port MAC address; and outward facing MEPs on port channels use the Bridge-Brain MAC address of the first member link. When port channel members change, the identities of outward facing MEPs do not have to change.	IP Core, Product	Configuration
Interface	A link to the interface on which the maintenance point is configured. This property includes all interface types that can be configured with CFM maintenance points.	IP Core, Product	Configuration

CFM Maintenance Endpoint

The CFM Maintenance Endpoint object represents an instance of a CFM Maintenance Endpoint (MEP),. Unlike MIPs, MEPs are associated by a CFM Maintenance Association (S-VLAN).

Table 19-4 CFM Maintenance Endpoints (IMaintenanceEndPoints)

Attribute Name	Attribute Description	Scheme	Polling Interval
Id	The ID of the MEP (an integer from *1* and *8191*). It identifies the MEP in CFM communications and to catalog CFM frames in the local CFM database. The MEP ID is meaningful throughout the CFM domain and through the maintenance association.	IP Core, Product	Configuration
Continuity Check Status	Current MEP status sent to other MEPs and MIPs via multicast CCMs (*Unknown*, *MEP active*, *MEP inactive*, *MEP enabled*, *MEP disabled*). CCMs are confined to a domain and S-VLAN.	IP Core, Product	Configuration
direction	Direction of the MEP (*inward facing*, *outward facing*). Inward facing means the MEP communicates through the Bridge Relay function and uses the Bridge-Brain MAC address. Outward facing means that the MEP communicates through the wire. Outward facing MEPs can be configured on routed ports and switch ports. A MIP configuration at a level higher than the level of the outward facing MEP is not required.	IP Core, Product	Configuration
cfmRemoteMaintenanceEndPoints	An array listing all the remote CFM MEPs that were discovered through this MEP. Properties for each remote MEP are used to establish CFM topology between CFM MEPs.	IP Core, Product	Configuration

CFM Maintenance Association

The CFM Maintenance Association object models a grouping of CFM Maintenance Endpoint.

Table 19-5 CFM Maintenance Association (IMaintenanceAssociation)

Attribute Name	Attribute Description	Scheme	Polling Interval
name	The Association name.	IP Core, Product	Configuration
associationType	The Association type (*Unknown*, *Bridge Domain VLAN*, *Bridge Domain*, *Port*, *Pseudowire*).	IP Core, Product	Configuration
maximalMeps	The maximum number of MEPs that can be configured on the Maintenance Association.	IP Core, Product	Configuration
continuityCheckInterval	The configured time interval between continuity checks performed by the Maintenance Association's MEPs.	IP Core, Product	Configuration

Table 19-5 CFM Maintenance Association (IMaintenanceAssociation) (continued)

Attribute Name	Attribute Description	Scheme	Polling Interval
continuityCheckEnable	Indicates whether continuity checking is enabled for the Association. CFM continuity checks are periodic heartbeat messages exchanged between the MEPs under the association. They allow MEPs to discover each other and CFM Maintenance Intermediate Points to discover the MEPs.	IP Core, Product	Configuration
crossCheckEnable	Indicates whether cross-checking is enabled for the Association. CFM cross-checking verifies that all endpoints of a service are operational. It is timer-driven and performed once.	IP Core, Product	Configuration
Direction	The direction of the association (*up*, *down*, *unknown*).	IP Core, Product	Configuration
Inner VLAN	The inner or customer VLAN ID.	IP Core, Product	Configuration
MaximalMeps	Maximum number of maintenance endpoints that can be configured on the maintenance association.	IP Core, Product	Configuration
bridge	Object Identifier of the bridge on which the association (VLAN) is configured.	IP Core, Product	Configuration
maintenanceEndPoints	An array of the CFM Maintenance Endpoint configured within the bounds of the CFM Maintenance Domain.	IP Core, Product	Configuration
RemoteMaintenanceEndPoints	Remote MEPs configured on other CFM-configured devices in the network. Each MEP can communicate with several remote MEPs.	IP Core, Product	Configuration

CFM Maintenance Intermediate Point

The CFM Maintenance Intermediate Point object represents a single instance of a CFM Maintenance Intermediate Point (MIP). Unlike MEPs, MIPs are not grouped by CFM Maintenance Associations (S-VLAN). Instead, they are grouped by CFM Maintenance Domain (using the Level parameter) and for all S-VLANs enabled or allowed on a port.

Table 19-6 CFM Maintenance Intermediate Point (IMaintenanceIntermediatePoint)

Attribute Name	Attribute Description	Scheme	Polling Interval
level	The level defined for this MIP. This is the same as the Level parameter defined for CFM Maintenance Domains: An integer from 0 to 7, assigned to each MIP for the purpose of creating hierarchical relationships among MIPs. All CFM frames at a level lower than the level assigned to the MIP are stopped and dropped, independent of whether they originate from the wire or relay function. All CFM frames at a higher level than the MIP are forwarded, independent of whether they arrive from the wire or relay function.	IP Core, Product	Configuration
cfmInterface	The normalized name of the interface on which the MIP is configured.	IP Core, Product	Configuration
isAutocreated	Indicates whether this MIP was created automatically (*true*) or by entering properties manually using the command-line interface (CLI) (*false*).	IP Core, Product	Configuration

Table 19-6 CFM Maintenance Intermediate Point (IMaintenanceIntermediatePoint) (continued)

Attribute Name	Attribute Description	Scheme	Polling Interval
Vlans	A list of the VLANs in which this MIP participates. A MIP configured on an interface normally functions via maintenance domain (level) and for all S-VLANs enabled or allowed on that port. To limit its functionality, however, a CFM MIP can also be configured with a list of S-VLANs or associations.	IP Core, Product	Configuration
InnerVlans	A list of the inner VLANs in which this MIP participates. A CFM maintenance intermediate point configured on an interface functions per maintenance domain (level) and for all inner VLANs enabled or allowed on a port.	IP Core, Product	Configuration
macAddress	The MAC address that identifies the CFM entity (for example, *bridge-brain MAC*).	IP Core, Product	Configuration

OAM Data

The OAM Data object represents support and status of OAM functions on Ethernet-like interfaces.

Table 19-7 OAM Data (IOAMData)

Attribute Name	Attribute Description	Scheme	Polling Interval
Admin Status	Used to enable and disable the OAM sublayer entity.	IP Core, Product	Configuration
Maximum PDU Rate	The maximum transmission and reception rate of OAM PDUs as part of the discovery process (packets per second).	IP Core, Product	Configuration
Minimum PDU Rate	The minimum transmission and reception rate of OAM PDUs as part of the discovery process (packets per second).	IP Core, Product	Configuration
Link Timeout	The time (in seconds) after which a device declares the OAM peer to be non-operational and resets its state machine.	IP Core, Product	Configuration
High Threshold Action	The action to be taken when a monitored error has been detected to have crossed a user-specified threshold.	IP Core, Product	Configuration
Link Fault Action	The action to be taken when loss of signal (link fault) is detected.	IP Core, Product	Configuration
Dying Gasp Action	Used to indicate unrecoverable event conditions that should be transmitted to the peer OAM entity.	IP Core, Product	Configuration
Critical Event Action	Used to signal an unspecified critical link event condition.	IP Core, Product	Configuration
Mode	The local client OAM sublayer entity configuration status, either active or passive controlling of the peer's OAM configurations.	IP Core, Product	Configuration
Unidirectional	Indicates whether the OAM local entity supports the transmission of OAMPDUs on links that are operating in unidirectional mode.	IP Core, Product	Configuration
Link Monitor	Indicates whether a mechanism is provided to support event notification that permits the inclusion of diagnostic information.	IP Core, Product	Configuration

Table 19-7 OAM Data (IOAMData) (continued)

Attribute Name	Attribute Description	Scheme	Polling Interval
Remote Loopback	Indicates whether data link layer frame-level loopback mode is supported.	IP Core, Product	Configuration
Port Status	The operational status of the local port.	IP Core, Product	Configuration
Loopback Status	Indicates the Ethernet OAM loopback status of this interface (no loopback, remote loopback, initiating loopback, terminating loopback, local loopback, unknown.)	IP Core, Product	Configuration
Remote Data	OAM provides a mechanism to detect the presence of an OAM sublayer at the remote DTE.	IP Core, Product	Configuration
Ethernet Port	OID of the Ethernet Port	IP Core, Product	Configuration

OAM Remote Data

The OAM Remote Data object consists of interface remote peer summarized OAM data.

Table 19-8 OAM Remote Data (IOAMRemoteData)

Attribute Name	Attribute Description	Scheme	Polling Interval
MAC Address	The MAC address of the remote client.	IP Core, Product	Configuration
Vendor	The vendor name of the remote client.	IP Core, Product	Configuration
Mode	The remote client OAM sublayer entity configuration status, either active or passive controlling of the peer's OAM configurations.	IP Core, Product	Configuration
Unidirectional	Indicates whether the remote OAM entity supports the transmission of OAMPDUs on links that are operating in unidirectional mode	IP Core, Product	Configuration
Link Monitor	Indicates whether a mechanism is provided to support event notification that permits the inclusion of diagnostic information.	IP Core, Product	Configuration
Remote Loopback	Indicates whether data link layer frame-level loopback mode is supported.	IP Core, Product	Configuration

Ethernet LMI

The Ethernet LMI object contains the properties that control the Ethernet LMI protocol between the customer edge (CE) network element and the provider edge (PE) network element, on the PE-CE UNI link.It notifies the CE of connectivity status and configuration parameters of Ethernet services available on the CE port. Ethernet LMI interoperates with an OAM protocol, such as CFM, that runs within the provider network to collect OAM status. Such a service will exist once per context and per device. It contains ELMI Interfaces (IELMIInterfaces) and Device EVC (IDeviceEVC).

Table 19-9 Ethernet LMI (IEthernetLMI)

Attribute Name	Attribute Description	Scheme	Polling Interval
ELMI Enabled State	Indicates whether or not the Ethernet LMI protocol is enabled on the interface.	IP Core, Product	Configuration
ELMI Mode	The Ethernet LMI mode, either CE or PE.	IP Core, Product	Configuration
ELMI Interfaces	The interfaces on which Ethernet LMI is configured.	IP Core, Product	Configuration
Device EVCs	The Ethernet Virtual Connections configured on the device.	IP Core, Product	Configuration

Device EVC

The Device EVC object represents a port-level point-to-point or multipoint-to-multipoint Layer 2 circuit. It is an end-to-end representation of a single instance of a Layer 2 service being offered by a provider to a customer. It embodies the different parameters on which the service is being offered. A service instance is the instantiation of an EVC on a given port on a given router.

Table 19-10 Device EVC (IDeviceEVC)

Attribute Name	Attribute Description	Scheme	Polling Interval
EVC Name	The name of the EVC.	IP Core, Product	Configuration
EVC Status	The status of the EVC (*Active, Partially Active, Inactive*), The EVC status can be used by a customer edge (CE) device either to find an alternative path in to the service provider network or, in some cases, to revert to a backup path over Ethernet or over another alternative service such as Frame Relay or ATM.	IP Core, Product	Status
EVC Type	The type of EVC (*Point-to-point, Multipoint-to-Multipoint*).	IP Core, Product	Configuration
Maintenance Association	The CFM Maintenance Association which uniquely identifies a service profile within the Maintenance Domain.	IP Core, Product	Configuration
Configured Remote UNI Count	The number of configured remote UNIs.	IP Core, Product	Configuration
Active Remote UNI Count	The number of active remote UNIs.	IP Core, Product	Configuration
UNI Interfaces	The UNI interfaces configured for Ethernet LMI.	IP Core, Product	Configuration

UNI Properties

The UNI Properties object holds the properties for the user-network interface (UNI). This IMO is mapped to the UniProperties in maps.xml.

Table 19-11 UNI Properties (IUNIProperties)

Attribute Name	Attribute Description	Scheme	Polling Interval
UNI ID	The ID of the local user-network interface (UNI).	IP Core, Product	Configuration
Service Multiplexing Enabled	Returns a boolean value (true or false), to indicate whether service multiplexing is enabled. If more than one EVC is allowed, service multiplexing can be enabled (true).	IP Core, Product	Configuration
Bundling Enabled	Returns a boolean value (true or false) to indicate whether bundling is enabled. This is set as true when configuring the UNI by supporting only one EVC with one or more VLANs.	IP Core, Product	Configuration
Bundling Type	The Bundling service attribute enables two or more VLAN IDs to be mapped to a single EVC at a UNI. With bundling, the provider and subscriber must agree on the VLAN IDs used at the UNI and the mapping between each VLAN ID and a specific EVC. A special case of bundling is where every VLAN ID at the UNI interface maps to a single EVC. This service attribute is called all-to-one bundling.	IP Core, Product	Configuration

UNI Interfaces

The UNI Interfaces object represents the identity and the status of the UNI interfaces configured for Ethernet LMI.

Table 19-12 UNI Interfaces (IUNIInterfaces)

Attribute Name	Attribute Description	Scheme	Polling Interval
UNI Status	The status of the UNI interface (*up, down*).	IP Core, Product	Status
UNI ID	The ID of the UNI.	IP Core, Product	Configuration
Interface Name	The name of the UNI.	IP Core, Product	Configuration
VLAN List	List of VLANs configured on the interface.	IP Core, Product	Configuration
LMI Link Status	The status of the LMI link (*up, down*).	IP Core, Product	Status
Interface OID	OID of the UNI.	N/A	N/A
Is UNI Local	Boolean UNI location, either local or remote.	IP Core, Product	Configuration

ELMI Interfaces

The ELMI Interfaces object holds the timers and counters used to assess and notify the CE of connectivity status and configuration parameters of Ethernet services available on the CE port.

Table 19-13 ELMI Interfaces (IELMIInterfaces)

Attribute Name	Attribute Description	Scheme	Polling Interval
Interface Name	The name of the Ethernet LMI interface.	IP Core, Product	Configuration
Interface OID	The OID of the Ethernet LMI interface.	N/A	N/A
T391	Polling timer on the customer equipment. A polling timer sends status inquiries and records errors when status messages are not received. The range is from 5 to 30 seconds; the default is 10 seconds.	IP Core, Product	Configuration
T392	Polling verification timer for the metro Ethernet network or the timer to verify received status inquiries. The range is from 5 to 30 seconds, or 0 for disabled timer. The default is 15 seconds.	IP Core, Product	Configuration
N391	Event counter on the customer equipment. The counter polls the status of the UNI and all Ethernet virtual connections (EVCs). The range is from 1 to 65000; the default is 360.	IP Core, Product	Configuration
N393	Event counter for the metro Ethernet network. The range is from 1 to 10; the default is 4.	IP Core, Product	Configuration

Vendor-Specific Inventory and IMOs

There are no vendor-specific IMOs for this technology.

Network Topology

Please see Chapter 38, "Cisco ANA VNE Topology". There is no topology support for CFM.

Service Alarms

The following alarms are supported for this technology:

- CFM Domain Fault, page 41-15