# X. YANG module for Ethernet Link OAM (ELO)

## **X. 1 Introduction**

The IEEE 802.3ah Ethernet in the First Mile (EFM) Task Force added management capabilities to Ethernet-like interfaces to provide some basic operations, administration and maintenance (OAM) functions. The defined functionality includes discovery, error signaling, loopback, and link monitoring. This clause defines a portion of the YANG module for use with NETCONF or RESTCONF to manage these Ethernet-like interface capabilities.

## **X.2 Overview**

Ethernet OAM is composed of a core set of functions and a set of optional functional groups as described in Clause 57 of IEEE Std 802.3. The core functions include discovery operations (determining if the other end of the link is OAM capable and what OAM functions it supports), state machine implementation, and some critical event flows.

Ethernet OAM provides single-hop functionality in that it works only between two directly connected Ethernet stations. Ethernet OAM has three functional objectives, which are detailed in x.2.1 through x.2.3. The definition of a basic Ethernet OAM protocol data unit is given in x.2.4.

[Editor’s note: texts marked in yellow to be filled.]

## **X.2.1 Remote fault indication**

Remote fault indication provides a mechanism for one end of an Ethernet link to signal the other end that the receive path is non-operational. Some Ethernet Physical Layers offer mechanisms to signal this condition at the Physical Layer. Ethernet OAM added a mechanism so that some Ethernet Physical Layers can operate in unidirectional mode, allowing frames to be transmitted in one direction even when the other direction is non-operational. Traditionally, Ethernet PHYs do not allow frame transmission in one direction if the other direction is not operational. Using this mode, Ethernet OAM allows frame-based signaling of remote fault conditions while still not allowing higher layer applications to be aware of the unidirectional capability. This clause includes mechanisms for capturing that fault information and reflecting such information in data nodes and notifications within the NETCONF management framework.

## **X.2.2 Link monitoring**

Ethernet OAM includes event signaling capability so that one end of an Ethernet link can indicate the occurrence of certain important events to the other end of the link. This happens via layer 2 protocols. This clause defines methods for incorporating the occurrence of these events, at both the local end and the far end of the link, into the YANG-based management framework.

Ethernet OAM also includes mechanisms for one Ethernet station to query another directly connected Ethernet station about the status of its Ethernet interface variables and status. This clause does not include mechanisms for controlling how one Ethernet endpoint may use this functionality to query the status or statistics of a peer Ethernet entity.

## **X.2.3 Remote loopback**

Remote loopback is a link state where the peer Ethernet entity echoes every received packet (without modifications) back onto the link. Remote loopback is intrusive in that the other end of the link is not forwarding traffic from higher layers out over the link. This clause defines data nodes controlling loopback operation and reading the status of the loopback state.

## **X.2.4 Ethernet OAM protocol data units**

An Ethernet OAM protocol data unit is a valid Ethernet frame with a destination Media Access Control (MAC) address equal to the reserved MAC address for Slow Protocols (see Annex 57A of IEEE Std 802.3), a lengthOrType field equal to the reserved type for Slow Protocols, and a Slow Protocols subtype equal to that of the subtype reserved for Ethernet OAM.

OAMPDU is used throughout this clause as an abbreviation for Ethernet OAM protocol data unit. OAMPDUs are the mechanism by which two directly connected Ethernet interfaces exchange OAM information.

## **X.3 Mapping of IEEE 802.3 managed objects**

This subclause contains the mapping between the YANG data nodes defined in this clause and the attributes defined in Clause 30 of IEEE Std 802.3. Table x-x provide the mapping between the ieee802-ethernet-link-oam module data nodes and the OAM attributes of Clause 30 of IEEE Std 802.3.

**Table x-x-mapping between IEEE 802.3 managed objects and YANG data nodes**

|  |  |  |  |
| --- | --- | --- | --- |
| **IEEE 802.3 managed object** | | **Corresponding YANG data nodes** | |
| **Managed objects** | **Attributes** | **YANG container** | **Data nodes** |
| oOAM | 30.3.6.1.2 aOAMAdminState  30.3.6.2.1 acOAMAdminControl | interfaces/ interface/ ethernt/link-oam | admin |
| aOAMMode | interfaces/ interface/ ethernt/link-oam | mode |
| 30.3.6.1.6 aOAMLocalConfiguration  30.3.6.1.7 aOAMRemoteConfiguration | mib-retrieval |
| remote-loopback |
| udlf |
| interfaces/ interface/ ethernt/link-oam/link-monitor | monitoring |
| [802.3] 57.5.3  30.3.6.1.34 aOAMLocalErrSymPeriodConfig  30.3.6.1.36 aOAMLocalErrFrameConfig  30.3.6.1.38 aOAMLocalErrFramePeriodConfig  30.3.6.1.40 aOAMLocalErrFrameSecsSummaryConfig  30.3.6.1.42 aOAMLocalErrSymPeriodConfig | interfaces/ interface/ ethernt/link-oam/link-monitor/event-type | threshold-type |
| window |
| threshold |
| [802.3] 57.1.2:a | interfaces-state/ interface/ ethernt/link-oam | rx-fault |
|  |  |
| [RFC-4878] dot3OamOperStatus, [802.3] 30.3.6.1.4, 30.3.6.1.10, 30.3.6.1.11 | interfaces-state/ interface/ ethernt/link-oam/discovery-info/local | operational-status |
| 30.3.6.1.14 aOAMLocalState | loopback-mode |
| 30.3.6.1.3 aOAMMode | mode |
| 30.3.6.1.12 aOAMLocalRevision | revision |
| 30.3.6.1.8 aOAMLocalPDUConfiguration | mtu |
| 30.3.6.1.6 aOAMLocalConfiguration | interfaces-state/ interface/ ethernt/link-oam/ discovery-info/local /functions-supported | uni-directional-link-fault |
| loopback |
| link-monitoring |
| mib-trtrieval |
| 30.3.6.1.5 aOAMRemoteMACAddress | interfaces-state/ interface/ ethernt/link-oam/ discovery-info/remote | mac-address |
| 30.3.6.1.16 aOAMRemoteVendorOUI | vendor-oui |
| 30.3.6.1.17 aOAMRemoteVendorSpecificInfo | vendor-info |
| 30.3.6.1.15 aOAMRemoteState | loopback-mode |
| 30.3.6.1.3 aOAMMode | mode |
| 30.3.6.1.13 aOAMRemoteRevision | revision |
| 30.3.6.1.9 .aOAMRemotePDUConfiguration | mtu |
| 30.3.6.1.7 aOAMRemoteConfiguration | interfaces-state/ interface/ ethernt/link-oam/ discovery-info/remote/functions-supported | Uni-directional-link-fault |
| loopback |
| link-monitoring |
| mib-retrieval |
| 802.3.1 Dot3OamEventLogEntry | interfaces-state/ interface/ethernt/link-oam/event-log/event-log-entry | index |
| oui |
| timestamp |
| location |
| running-total |
| event-total |
| 30.3.6.1.10 aOAMLocalFlagsField  30.3.6.1.11 aOAMRemoteFlagsField | event-type |
| [802.3] 57.5.3  30.3.6.1.35 aOAMLocalErrSymPeriodEvent  30.3.6.1.37 aOAMLocalErrFrameEvent  30.3.6.1.38 aOAMLocalErrFramePeriodConfig  30.3.6.1.41 aOAMLocalErrFrameSecsSummaryEvent  30.3.6.1.42 aOAMRemoteErrSymPeriodEvent  30.3.6.1.43 aOAMRemoteErrFrameEvent  30.3.6.1.44 aOAMRemoteErrFramePeriodEvent  30.3.6.1.45 aOAMRemoteErrFrameSecsSummaryEvent | interfaces-state/ interface/ ethernt/link-oam/event-log/event-log-entry/threshold | threshold-event-type |
| window |
| threshold |
| value |
| [RFC-4878] Dot3OamStatsEntry  30.3.6.1.20 aOAMInformationTx | interfaces-state/ interface/ ethernt/link-oam/statistics | information-tx |
| 30.3.6.1.21 aOAMInformationRx | information-rx |
| 30.3.6.1.22 aOAMUniqueEventNotificationTx | unique-event-notification-tx |
| 30.3.6.1.24 aOAMUniqueEventNotificationRx | unique-event-notification-rx |
| 30.3.6.1.23 aOAMDuplicateEventNotificationTx | duplicate-event-notificate-tx |
| 30.3.6.1.25 aOAMDuplicateEventNotificationRx | duplicate-event-notificate-rx |
| 30.3.6.1.26 aOAMLoopbackControlTx | loopback-control-tx |
| 30.3.6.1.27 aOAMLoopbackControlRx | loopback-control-rx |
| 30.3.6.1.28 aOAMVariableRequestTx | variable-request-tx |
| 30.3.6.1.29 aOAMVariableRequestRx | variable-requeste-rx |
| 30.3.6.1.30 aOAMVariableResponseTx | variable-response-tx |
| 30.3.6.1.31 aOAMVariableResponseRx | variable-response-rx |
| 30.3.6.1.32 aOAMOrganizationSpecificTx | org-specific-tx |
| 30.3.6.1.33 aOAMOrganizationSpecificRx | org-specific-rx |
| 30.3.6.1.18 aOAMUnsupportedCodesTx | unsupported-condes-tx |
| 30.3.6.1.19 aOAMUnsupportedCodesRx | unsupported-codes-rx |
| 30.3.6.1.46 aFramesLostDueToOAMError | frames-lost-due-to-oam |
| 30.3.6.1.35 aOAMLocalErrSymPeriodEvent  Errored Symbols field | local-error-symbol-period-log-entries |
| 30.3.6.1.37 aOAMLocalErrFrameEvent  Errored Frames field | local-error-frame-log-entries |
| 30.3.6.1.39 aOAMLocalErrFramePeriodEvent  Errored Frames field | local-error-frame-period-log-entries |
| 30.3.6.1.41 aOAMLocalErrFrameSecsSummaryEvent  Errored Frame Seconds Summary field | local-error-frame-second-log-entries |
| 30.3.6.1.42 aOAMRemoteErrSymPeriodEvent  Errored Symbols field | remote-error-symbol-period-log-entries |
| 30.3.6.1.43 aOAMRemoteErrFrameEvent  Errored Frames field | remote-error-frame-log-entries |
| 30.3.6.1.44 aOAMRemoteErrFramePeriodEvent  Errored Frames field | remote-error-frame-period-log-entries |
| 30.3.6.1.45 aOAMRemoteErrFrameSecsSummaryEvent  Errored Frame Seconds Summary field | remote-error-frame-second-log-entries |

[Editor’s notes: dot3OamLoopbackIgnoreRx is in MIB codes, but not included in the mapping Table 6-1 of IEEE std 802.3.1 MIB spec. Ask for direction of this attribute, whether adding it to ELO module.]

## **X.5 Security considerations for Ethernet operations, administration, and maintenance (OAM) module**

The readable data nodes in this module can provide information about network traffic, and therefore, they may be considered sensitive. In particular, OAM provides mechanisms for reading the Clause 30 IEEE 802.3 management attributes from a link partner via a layer 3 protocol. IEEE 802.3 OAM does not include encryption or authentication mechanisms. It should not be used in environments where this interface information is considered sensitive, and where the facility terminations are unprotected. By default, OAM is disabled on Ethernet-like interfaces and is therefore not a risk.

IEEE 802.3 OAM is designed to support deployment in access and enterprise networks. In access networks, one end of a link is the CO-side, and the other is the CPE-side, and the facilities are often protected in wiring cages or closets. In such deployments, it is often the case that the CO-side is protected from access from the CPE-side. Within IEEE 802.3 OAM, this protection from remote access is accomplished by configuring the CPE-side in passive mode using the mode leaf. This prevents the CPE from accessing functions and information at the CO-side of the connection. In enterprise networks, read-only interface information is often considered non-sensitive.

The frequency of OAM PDUs on an Ethernet interface does not adversely affect data traffic, as OAM is a slow protocol with very limited bandwidth potential, and it is not required for normal link operation. Although there are a number of objects in this module with read-write or read-create MAX-ACCESS, they have limited effects on user data.

The loopback capability of OAM can have potentially disruptive effects; when remote loopback is enabled, the remote station automatically transmits all received traffic back to the local station except for OAM traffic. This completely disrupts all higher layer protocols such as bridging, IP, and Netconf/Restconf. Therefore, an attribute (dot3OamLoopbackIgnoreRx) was introduced to control whether the local station processes or ignores received loopback commands.

The administrative state and mode are also configuration nodes. Disabling OAM can interrupt management activities between peer devices, potentially causing serious problems. Setting the mode node to an undesired value can allow access to Ethernet monitoring, events, and functions that may not be acceptable in a particular deployment scenario. In addition to loopback functionality, Ethernet interface statistics and events can be accessed via the OAM protocol, which may not be desired in some circumstances.

OAM event configuration also contains configuration nodes. These nodes control whether events are sent, and at what thresholds. Note that the frequency of event communication is limited by the frequency limits of Slow Protocols on Ethernet interfaces. Also, the information available via OAM events is also available via OAM Variable Requests. Access to this information via either OAM events or Variable Requests is controlled by the admin and mode nodes. As mentioned previously, inadequate protection of these variables can result in access to link information and functions.

## **X.6 Module definition**

### **X.6.1 Tree hierarchy**

### **X.6.2 YANG module definition**