

Ethernet Local Management Interface

This chapter provides conceptual and configuration information of the Ethernet Local Management Interface protocol.

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Ethernet Local Management Interface

Ethernet Local Management Interface (E-LMI) is an asymmetric protocol that runs on the Provider Edge (PE) to Customer Edge (CE) link. The user-facing Provider Edge (uPE) device uses E-LMI to communicate status and configuration parameters of Ethernet Virtual Circuits (EVCs) available on the User-Network Interface (UNI) to the CE device. E-LMI defines the message formats and procedures for conveying the information from uPE to CE, however it does not define the method by which the information is collected on the PE.

The basic operation of E-LMI involves the uPE device providing connectivity status and configuration parameters to the CE using the STATUS messages in response to STATUS ENQUIRY messages set by the CE to the uPE.

E-LMI Communication

This section discusses the E-LMI messaging and system parameter details.

Messaging

The E-LMI protocol as defined by the MEF 16 standard, defines the use of only two message types—STATUS ENQUIRY and STATUS.

These E-LMI messages consist of required and optional fields called information elements, and all information elements are associated with assigned identifiers. All messages contain the Protocol Version, Message Type, and Report Type information elements, followed by optional information elements and sub-information elements.

E-LMI messages are encapsulated in 46- to 1500-byte Ethernet frames, which are based on the IEEE 802.3 untagged MAC-frame format. E-LMI frames consist of the following fields:

- Destination address (6 bytes)—Uses a standard MAC address of 01:80:C2:00:00:07.
- Source address (6 bytes)—MAC address of the sending device or port.
- E-LMI Ethertype (2 bytes)—Uses 88-EE.
- E-LMI PDU (46–1500 bytes)—Data plus 0x00 padding as needed to fulfill minimum 46-byte length.
- CRC (4 bytes)—Cyclic Redundancy Check for error detection.

For more details about E-LMI messages and their supported information elements, refer to the *Metro Ethernet Forum, Technical Specification MEF 16, Ethernet Local Management Interface (E-LMI), January 2006*.

Parameters

For correct interaction between the CE and the PE, each device has two configurable parameters. The CE uses a Polling Timer (PT) and a Polling Counter; the PE uses a Polling Verification Timer (PVT) and a Status Counter.

Cisco Proprietary Remote UNI Details Information Element

The E-LMI MEF 16 specification does not define a way to send proprietary information.

To provide additional information within the E-LMI protocol, the Cisco IOS XR software implements a Cisco-proprietary information element called Remote UNI Details to send information to the CE about remote UNI names and states. This information element implements what is currently an unused identifier from the E-LMI MEF 16 specification.

E-LMI Operation

The basic operation of E-LMI consists of a CE device sending periodic STATUS ENQUIRY messages to the PE device, followed by mandatory STATUS message responses by the PE device that contain the requested information. Sequence numbers are used to correlate STATUS ENQUIRY and STATUS messages between the CE and PE.

The CE sends the following two forms of STATUS ENQUIRY messages called Report Types:

- E-LMI Check—Verifies a Data Instance (DI) number with the PE to confirm that the CE has the latest E-LMI information.
- Full Status—Requests information from the PE about the UNI and all EVCs.

The CE device uses a polling timer to track sending of STATUS ENQUIRY messages, while the PE device can optionally use a Polling Verification Timer (PVT), which specifies the allowable time between transmission

of the PE's STATUS message and receipt of a STATUS ENQUIRY from the CE device before recording an error.

In addition to the periodic STATUS ENQUIRY/STATUS message sequence for the exchange of E-LMI information, the PE device also can send asynchronous STATUS messages to the CE device to communicate changes in EVC status as soon as they occur and without any prompt by the CE device to send that information.

Both the CE and PE devices use a status counter (N393) to determine the local operational status of E-LMI by tracking consecutive errors received before declaring a change in E-LMI protocol status.

Supported Functions

The Cisco NCS 4000 Series Router serves as the PE device for E-LMI, and supports the following PE functions:

- Supports the E-LMI protocol on Ethernet physical interfaces that are configured with Layer 2 subinterfaces as Ethernet Flow Points (EFPs), which serve as the EVCs about which the physical interface reports status to the CE. The Cisco IOS XR software does not support a specific manageability context for an Ethernet Virtual Connection (EVC).
- Provides the ability to configure the following E-LMI options defined in the MEF 16 specification:
  - T392 Polling Verification Timer (PVT)
  - N393 Status Counter
- Sends notification of the addition and deletion of an EVC.
- Sends notification of the availability (active) or unavailability (inactive, partially active) status of a configured EVC.
- Sends notification of the local UNI name.
- Sends notification of remote UNI names and states using the Cisco-proprietary Remote UNI Details information element, and the ability to disable the Cisco-proprietary Remote UNI information element.
- Sends information about UNI and EVC attributes to the CE (to allow the CE to auto-configure these attributes), including:
  - CE-VLAN to EVC Map
  - CE-VLAN Map Type (Bundling, All-to-one Bundling, Service Multiplexing)
  - Service Type (point-to-point or multipoint)
- Uses CFM Up MEPs to retrieve the EVC state, EVC Service Type, and remote UNI details.
- Provides the ability to retrieve the per-interface operational state of the protocol (including all the information currently being communicated by the protocol to the CE) using the command-line interface (CLI) or Extensible Markup Language (XML) interface.
- Supports one E-LMI session per physical interface; maximum of 80 per linecard.
- Supports up to 4000 EVCs total per linecard for all physical interfaces enabled for E-LMI.

Limitations

This sections lists the implementation limitations of the E-LMI protocol. The following are not supported:

- CE-specific features are not supported.
- Retrieval of the EVC status from MPLS OAM.
- Communication of UNI and EVC bandwidth profiles to the CE.
- Operation of the protocol during linecard MDR events.

Enable ELMI and configure the parameters

Before enabling E-LMI on a Cisco NCS 4000 router, complete the following tasks:

1. Create EVCs by configuring EFPs
2. Configure xconnect groups
3. Configure CFM
4. Configure UNI IDs

All of these tasks, have been discussed in the later sections.

E-LMI is configured per interface. It can be configured only on physical ethernet interfaces using CLI commands (or XML schema). The configuration items and their possible values are described in the following table:

Parameter	Description	Allowed value(s)	Default value
Status Counter	Threshold to the number of consecutive events before an operational state change is made.	2 to 10	4
Polling Verification Timer	Determines the interval for which the PE will wait for a status enquiry before reporting an error.	5 to 30 seconds; disabled	15 seconds
Remote UNI Extension	Disables transmission of Cisco-proprietary Remote UNI Details, to provide stricter conformance with the MEF standard.	disabled/ enabled	enabled
Log errors	Disables the syslog messages emitted when a protocol or reliability error is detected.	disabled/ enabled	enabled

Parameter	Description	Allowed value(s)	Default value
Log events	Disables the syslog messages emitted when a change to the operational status of the E-LMI protocol occurs.	disabled/ enabled	enabled

Prerequisites for Configuring E-LMI

Before you begin with the required tasks, be sure to complete the following requirements:

- Identify the local and remote UNIs in your network where you want to run E-LMI, and define a naming convention for them.
- Enable E-LMI on the corresponding CE interface link on a device that supports E-LMI CE operation.

Create EVC

EVCs for E-LMI are established by first configuring EFPs (Layer 2 subinterfaces) on the local UNI physical Ethernet interface link to the CE where E-LMI will be running, and also on the remote UNI link. Then, the EFPs need to be assigned to an xconnect domain to create the EVC.

Procedure

Step 1 **configure**

Example:

```
RP/0/router# configure
```

Enters global configuration mode.

Step 2 **interface** [**TenGigE**] *interface-path-id***.***subinterface* **l2transport**

Example:

```
RP/0/:router(config)# interface tengige 0/0/0/0.0 l2transport
```

Creates a VLAN subinterface in Layer 2 transport mode and enters Layer 2 subinterface configuration mode.

Step 3 **encapsulation dot1q** *vlan-id* [**, untagged** | **,** *vlan-id* | **–***vlan-id*] [**exact** | **ingress source-mac** *mac-address* | **second-dot1q** *vlan-id*]

Example:

```
RP/0/:router(config-subif)# encapsulation dot1q 1-20
```

Defines the matching criteria to map 802.1Q frames ingress on an interface to the appropriate service instance.

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

Example:

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

Saves configuration changes.

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

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

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

What to do next

Configure a xconnect group

Configure cross-connect (xconnect) groups

To configure a cross-connect group and assign EFPs, complete the following steps:

Procedure

Step 1 **configure**

Example:

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

Enters global configuration mode.

Step 2 **l2vpn**

Example:

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

Enters L2VPN configuration mode.

Step 3 **xconnect group** *xconnect-group-name*

Example:

```
RP/0/:router(config-l2vpn)# xconnect group g1
```

Enters the cross-connect (xconnect) group configuration mode.

Step 4 **interface** [**TenGigE**] *interface-path-id.subinterface*

Example:

```
RP/0/:router(config-l2vpn-xconnect)# interface TenGigE0/13/0/6.2
```

Associates the EFP (EVC) with the specified cross-connect group, where *interface-path-id* is specified as the *rack*/*slot*/*module*/*port* location of the interface and **.***subinterface* is the subinterface number.

Repeat this step for as many EFPs (EVCs) as you want to associate with the cross-connect group.

Step 5 **interface** [**TenGigE**] *interface-path-id.subinterface*

Example:

```
RP/0/:router(config-l2vpn-xconnect)# interface TenGigE0/13/0/7.2
```

Associates the EFP (EVC) with the specified cross-connect group , where *interface-path-id* is specified as the *rack*/*slot*/*module*/*port* location of the interface and **.***subinterface* is the subinterface number.

The cross-connect is between the two configured interfaces.

Step 6 **end** or **commit**

Example:

```
RP/0/:router(config-l2vpn-xconnect)# end
```

or

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

Saves configuration changes.

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

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

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

Step 7 **show l2vpn xconnect**

Example:

```
RP/0/:router # show l2vpn xconnect
Legend: ST = State, UP = Up, DN = Down, AD = Admin Down, UR = Unresolved,
```

```
        SB = Standby, SR = Standby Ready, (PP) = Partially Programmed

XConnect                    Segment 1                       Segment 2
Group      Name       ST    Description             ST      Description             ST
-----------------------    ------------------------------  ------------------------------
xconn_local
           xc3        UP    Te0/13/0/6.2            UP      Te0/13/0/7.2            UP
-------------------------------------------------------------------------------------------
```

Verifies the xconnect configuration.

For more configurations with xconnect groups, see Layer 2 Local Switching.

What to do next

Configure CFM

Configure Ethernet CFM

The Cisco NCS 4000 series router uses Ethernet CFM to monitor EVC status for E-LMI. To use CFM for E-LMI, a CFM maintenance domain and service must be configured on the router and the EFPs must be configured as CFM Maintenance End-points (MEP).

The minimum configuration to support E-LMI using Ethernet CFM is to configure a CFM maintenance domain and service on the router. Other CFM options can also be configured.

Procedure

Step 1 **configure**

Example:

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

Enters global configuration mode.

Step 2 **interface tengige** *interface-path-id*.*subinterface* **l2transport**

Example:

```
RP/0/:router(config)# interface tengige 0/0/0/0.0 l2transport
```

Enters Layer 2 subinterface configuration mode for the EFP.

Step 3 **ethernet cfm**

Example:

```
RP/0/:router(config-subif)# ethernet cfm
```

Enters Ethernet CFM interface configuration mode.

Step 4 **mep domain** *domain-name* **service** *service-name* **mep-id** *id-number*

Example:

```
RP/0/:router(config-if-cfm)# mep domain GLOBAL service CustomerA mep-id 22
```

Creates a MEP on an interface and enters interface CFM MEP configuration mode.

Step 5 **end** or **commit**

Example:

```
RP/0/:router(config-if-cfm-mep)# commit
```

Saves configuration changes.

Step 6 **show ethernet cfm peer meps**

Example:

```
RP/0/: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)
* - Multiple errors received    S - Standby

Domain local (level 3), Service custA
Up MEP on TenGigE0/13/0/6.2 MEP-ID 11
================================================================================
St     ID MAC Address    Port    Up/Downtime   CcmRcvd SeqErr   RDI Error
-- ----- -------------- ------- ------------ --------- ------ ----- -----
>    22 78ba.f99b.a074 Up      00:02:17            0      0     0     0

Up MEP on TenGigE0/13/0/7.2 MEP-ID 22
================================================================================
St     ID MAC Address    Port    Up/Downtime   CcmRcvd SeqErr   RDI Error
-- ----- -------------- ------- ------------ --------- ------ ----- -----
>    11 78ba.f99b.a073 Up      00:02:17            0      0     0     0
```

Verifies the CFM configuration.

For more CFM configurations, *see the CFM sections*.

What to do next

Provision UNI IDs

Configure UNI

It is recommended that you configure UNI names on the physical interface links to both the local and remote UNIs to aid in management for the E-LMI protocol. To configure UNI names, complete the following tasks on the physical interface links to both the local and remote UNIs:

Procedure

Step 1 **configure**

Example:

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

Enters global configuration mode.

Step 2 **interface TenGigE** *interface-path-id*

Example:

```
RP/0/:router(config)# interface tengige 0/0/0/0
```

Enters interface configuration mode for the physical interface.

Step 3 **ethernet uni id** *name*

Example:

```
RP/0/:router(config-if)# ethernet uni id PE1-CustA-Slot0-Port0
```

Specifies a name (up to 64 characters) for the Ethernet UNI interface link.

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

Example:

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

Saves configuration changes.

What to do next

Enable E-LMI

Enable E-LMI

E-LMI can be enabled only on physical ethernet interfaces.

Procedure

Step 1 **configure**

Example:

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

Enters global configuration mode.

Step 2 **interface** [**TenGigE**] *interface-path-id*

Example:

```
RP/0/:router# interface tengige 0/0/0/0
```

Enters interface configuration mode for the physical interface.

Step 3 **ethernet lmi**

Example:

```
RP/0/:router(config-if)# ethernet lmi
```

Enables Ethernet Local Managment Interface operation on an interface and enters interface Ethernet LMI configuration mode.

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

Example:

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

Saves configuration changes.

What to do next

Verify the E-LMI configuration

Use the **show ethernet lmi interfaces detail** command to display the values for the Ethernet LMI configuration for a particular interface, or for all interfaces. The following example shows sample output for the command:

```
RP/0/:router# show ethernet lmi interfaces detail
Interface: TenGigE0/13/0/6
  Ether LMI Link Status: Up
  UNI Id: PE1-CustA-slot13-Port6
  Line Protocol State: Up
  MTU: 1514 (1 PDU reqd. for full report)
  CE-VLAN/EVC Map Type: Service Multiplexing with no bundling (2 EVCs)
  Configuration: Status counter 4, Polling Verification Timer 15 seconds
  Last Data Instance Sent: 139
  Last Sequence Numbers: Sent 18, Received 211
  Reliability Errors:
    Status Enq Timeouts                 0 Invalid Sequence Number            0
    Invalid Report Type                 0

  Protocol Errors:
    Malformed PDUs                      0 Invalid Protocol Version           0
    Invalid Message Type                0 Out of Sequence IE                 0
    Duplicated IE                       0 Mandatory IE Missing               0
    Invalid Mandatory IE                0 Invalid non-Mandatory IE           0
    Unrecognized IE                     0 Unexpected IE                      0

  Full Status Enq Received  00:00:11 ago   Full Status Sent      00:00:11 ago
  PDU Received              00:00:01 ago   PDU Sent              00:00:01 ago
  LMI Link Status Changed   00:00:23 ago   Last Protocol Error      never
  Counters Cleared             never

  Sub-interface: TenGigE0/13/0/6.2
```

```
VLANs: 1100
EVC Status: Active
EVC Type: Point-to-Point
OAM Protocol: CFM
  CFM Domain: local (level 3)
  CFM Service: custA
Remote UNI Count: Configured = 1, Active = 1
Remote UNI Id                                                    Status
-------------                                                    ------
<Remote UNI Reference Id: 22>                                    Up
```

Configure Polling Verification Timer

The MEF T392 Polling Verification Timer (PVT) specifies the allowable time between transmission of a STATUS message and receipt of a STATUS ENQUIRY from the UNI-C before recording an error. The default value is 15 seconds.

To modify the default value or disable the PVT altogether, complete the following tasks:

Procedure

Step 1 **configure**

Example:

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

Enters global configuration mode.

Step 2 **interface** [**TenGigE**] *interface-path-id*

Example:

```
RP/0/:router# interface tengige 0/0/0/0
```

Enters interface configuration mode for the physical interface.

Step 3 **ethernet lmi**

Example:

```
RP/0/:router(config-if)# ethernet lmi
```

Enables Ethernet Local Managment Interface operation on an interface and enters interface Ethernet LMI configuration mode.

Step 4 **polling-verification-timer** {*interval* | **disable**}

Example:

```
RP/0/:router(config-if-lmi)# polling-verification-timer 30
```

Sets or disables the MEF T392 Polling Verification Timer for E-LMI operation, which specifies the allowable time (in seconds) between transmission of a STATUS message and receipt of a STATUS ENQUIRY from the UNI-C before recording an error. The default is 15.

Step 5 **end** or **commit**

Example:

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

Saves configuration changes.

Configure Status Counter

The MEF N393 Status Counter value is used to determine E-LMI operational status by tracking receipt of consecutive good packets or successive expiration of the PVT on packets. The default counter is four, which means that while the E-LMI protocol is in Down state, four good packets must be received consecutively to change the protocol state to Up, or while the E-LMI protocol is in Up state, four consecutive PVT expirations must occur before the state of the E-LMI protocol is changed to Down on the interface.

To modify the status counter default value, complete the following tasks:

Procedure

Step 1 **configure**

Example:

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

Enters global configuration mode.

Step 2 **interface** [**TenGigE**] *interface-path-id*

Example:

```
RP/0/:router# interface tengige 0/0/0/0
```

Enters interface configuration mode for the physical interface.

Step 3 **ethernet lmi**

Example:

```
RP/0/:router(config-if)# ethernet lmi
```

Enables Ethernet Local Management Interface operation on an interface and enters interface Ethernet LMI configuration mode.

Step 4 **status-counter** *threshold*

Example:

```
RP/0/:router(config-if-lmi)# status-counter 5
```

Sets the MEF N393 Status Counter value that is used to determine E-LMI operational status by tracking receipt of consecutive good and bad packets from a peer. The default is 4.

Step 5 **end** or **commit**

Example:

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

Saves configuration changes.

Disable Syslog Messages

The E-LMI protocol tracks certain errors and events whose counts can be displayed using the **show ethernet lmi interfaces** command.

To disable syslog messages for E-LMI errors or events, complete the following tasks:

Procedure

Step 1 **configure**

Example:

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

Enters global configuration mode.

Step 2 **interface** [**TenGigE**] *interface-path-id*

Example:

```
RP/0/:router# interface tengige 0/0/0/0
```

Enters interface configuration mode for the physical interface.

Step 3 **ethernet lmi**

Example:

```
RP/0/:router(config-if)# ethernet lmi
```

Enables Ethernet Local Managment Interface operation on an interface and enters interface Ethernet LMI configuration mode.

Step 4 **log** {**errors** | **events**} **disable**

Example:

```
RP/0/:router(config-if-lmi)# log events disable
```

Turns off syslog messages for E-LMI errors or events.

Step 5 **end** or **commit**

Example:

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

Saves configuration changes.

Disable Cisco-proprietary Remote UNI Details Information Element

To provide additional information within the E-LMI protocol, the Cisco IOS XR software implements a Cisco-proprietary information element called Remote UNI Details to send information to the CE about remote UNI names and states. This information element implements what is currently an unused identifier from the E-LMI MEF 16 specification.

To disable use of the Remote UNI Details information element, complete the following tasks:

Procedure

Step 1 **configure**

Example:

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

Enters global configuration mode.

Step 2 **interface** [**TenGigE**] *interface-path-id*

Example:

```
RP/0/:router# interface tengige 0/0/0/0
```

Enters interface configuration mode for the physical interface.

Step 3 **ethernet lmi**

Example:

```
RP/0/:router(config-if)# ethernet lmi
```

Enables Ethernet Local Managment Interface operation on an interface and enters interface Ethernet LMI configuration mode.

Step 4 **extension remote-uni disable**

Example:

```
RP/0/:router(config-if-lmi)# extension remote-uni disable
```

Disables transmission of the Cisco-proprietary Remote UNI Details information element in E-LMI STATUS messages.

Step 5 **end** or **commit**

Example:

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

Troubleshooting E-LMI Configuration

This section describes some basic information for troubleshooting your E-LMI configuration in the following topics:

Link Status Troubleshooting

The E-LMI protocol operational status is reported in the "Ether LMI Link Status" or "ELMI state" fields in the output of forms of the **show ethernet lmi interfaces** command. To investigate a link status other than "Up," consider the following guidelines:

- Unknown (PVT disabled)—Indicates that the Polling Verification Timer has been configured as disabled, so no status information can be provided. To see an "Up" or "Down" status, you must enable the PVT.
- Down—The E-LMI link status can be Down for the following reasons:
  - The PVT has timed out the number of times specified by the **status-counter** command. This indicates that STATUS ENQUIRY messages have not been received from the CE device. This can be for the following reasons:

    — The CE device is not connected to the PE device. Check that the CE device is connected to the interface on which E-LMI is enabled on the PE device.

    — The CE device is not sending Status Enquiries. Check that E-LMI is enabled on the CE interface which is connected to the PE device.

    — Protocol errors are causing the PVT to expire. The PVT is only reset when a valid (unerrored) STATUS ENQUIRY message is received.
  - The Line Protocol State is "Down" or "Admin Down."
  - The protocol has not yet started on the interface because it does not have useful information to provide, such as the UNI Id or details about EVCs. This is a symptom of provisioning misconfiguration.

Protocol State Troubleshooting

The E-LMI line protocol state is reported in the "Line Protocol State" or "LineP State" fields in the output of forms of the **show ethernet lmi interfaces** command. The line protocol state is the state of the E-LMI protocol on the physical interface.

To investigate a line protocol state other than Up, consider the following guidelines:

- Admin-Down—The interface is configured with the **shutdown** command. Use the **no shutdown** command to bring the interface up.
- Down—Indicates a fault on the interface. Run the **show interfaces** command to display both the interface state and the interface line protocol state for more information, and take the following actions to investigate further:
  - If both states are Down, this suggests a physical problem with the link (for example, the cable is not plugged into either the PE or CE device).

- If the interface state is Up but the line protocol state is Down, this suggests that an OAM protocol has brought the line protocol state down due to a fault. Use the **show efd interface** command for more information.