Using Link Layer Discovery Protocol in Multivendor Networks

Link Layer Discovery Protocol (LLDP), standardized by the IEEE as part of 802.1ab, enables standardized discovery of nodes, which in turn facilitates future applications of standard management tools such as Simple Network Management Protocol (SNMP) in multivendor networks. Using standard management tools makes physical topology information available and helps network administrators detect and correct network malfunctions and inconsistencies in configuration.

The Cisco implementation of LLDP is based on the IEEE 802.1ab standard.

Prerequisites for Using Link Layer Discovery Protocol in Multivendor Networks

The Type-Length-Value (TLV) types must be 0 through 127.

Restrictions for Using Link Layer Discovery Protocol in Multivendor Networks

Use of LLDP is limited to 802.1 media types such as Ethernet, Token Ring, and FDDI networks.

Information About Using Link Layer Discovery Protocol in Multivendor Networks

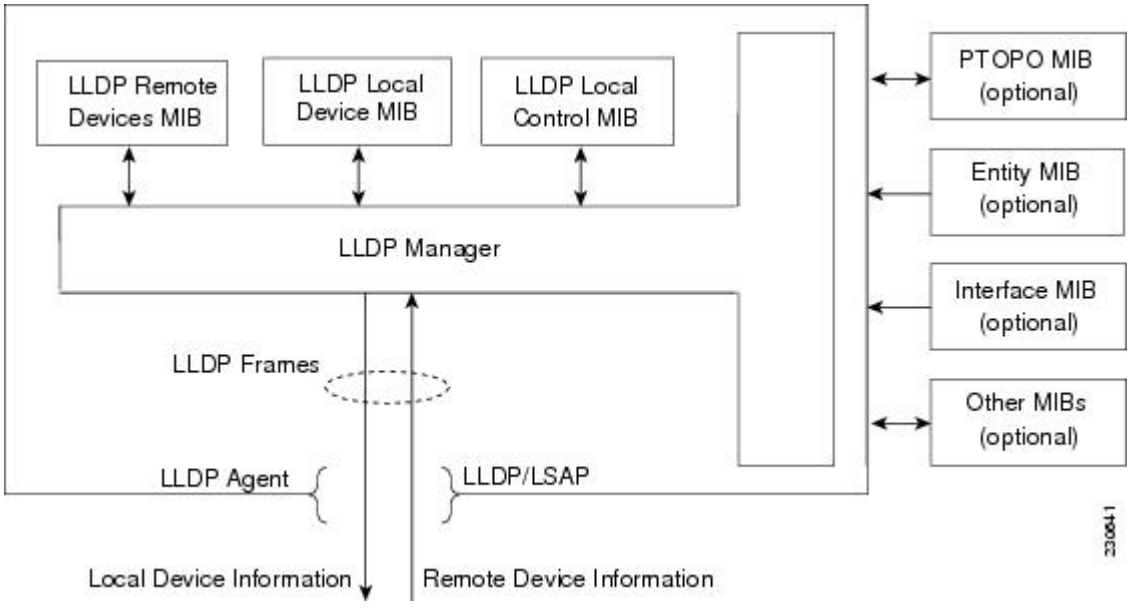
IEEE 802.1ab LLDP

IEEE 802.1ab Link Layer Discovery Protocol (LLDP) is an optional link layer protocol for network topology discovery in multivendor networks. Discovery information includes device identifiers, port identifiers, versions, and other details. As a protocol that aids network management, LLDP provides accurate network mapping, inventory data, and network troubleshooting information.

LLDP is unidirectional, operating only in an advertising mode. LLDP does not solicit information or monitor state changes between LLDP nodes. LLDP periodically sends advertisements to a constrained multicast address. Devices supporting LLDP can send information about themselves while they receive and record information about their neighbors. Additionally, devices can choose to turn off the send or receive functions independently. Advertisements are sent out and received on every active and enabled interface, allowing any device in a network to learn about all devices to which it is connected. Applications that use this information include network topology discovery, inventory management, emergency services, VLAN assignment, and inline power supply.

Note LLDP and Cisco Discovery Protocol can operate on the same interface.

The figure below shows a high-level view of LLDP operating in a network node.



When you configure LLDP or Cisco Discovery Protocol location information on a per-port basis, remote devices can send Cisco medianet location information to the switch. For more information, see the *Using Cisco Discovery Protocol module.*

TLV Elements

Link Layer Discovery Protocol (LLDP) uses Type-Length-Values (TLVs) to exchange information between network and endpoint devices. TLV elements are embedded in communications protocol advertisements and used for encoding optional information. The size of the type and length fields is fixed at 2 bytes. The size of the value field is variable. The type is a numeric code that indicates the type of field that this part of the message represents, and the length is the size of the value field, in bytes. The value field contains the data for this part of the message.

By defining a network-policy profile TLV, you can create a profile for voice and voice signalling by specifying the values for VLAN, class of service (CoS), differentiated services code point (DSCP), and tagging mode. These profile attributes are then maintained centrally on the switch and propagated to the phone.

- Power management TLV—Allows switches and phones to convey power information, such as how the device is powered on, power priority, and the power required by the device. Supports advertisement of fractional wattage power requirements, endpoint power priority, and endpoint and network connectivity-device power status. However, it does not support power negotiation between the endpoint and the network connectivity devices. When LLDP is enabled and a port is powered on, the power TLV determines the actual power requirement of the endpoint device, so that the system power budget can be adjusted. The switch processes the requests and either grants or denies power based on the current power budget. If the request is granted, the switch updates the power budget. If the request is denied, the switch turns off power to the port, generates a syslog message, and updates the power budget.

Note A system power budget is the default power allocated to a device based on its device class. However, the total power sourced from a switch is finite, and power budgeting is done by the power module based on the number of ports already being served, total power that can be served, and number of new ports that are requesting.

- Inventory management TLV—Allows an endpoint to send detailed inventory information about itself to the switch, including information hardware revision, firmware version, software version, serial number, manufacturer name, model name, and asset ID TLV.
- Location TLV—Provides location information from the switch to the endpoint device. The location TLV can send the following information:
  - Civic location information—Provides the civic address information and postal information. Examples of civic location information are street address, road name, and postal community name information.
  - ELIN location information—Provides the location information of a caller. The location is determined by the Emergency location identifier number (ELIN), a phone number that routes an emergency call to the local public safety answering point (PSAP). The PSAP can call back the emergency caller using the same number.

Benefits of LLDP

- Follows IEEE 802.1ab standard.
- Enables interoperability among multivendor devices.
- Facilitates troubleshooting of enterprise networks and uses standard network management tools.

- Provides extension for applications such as VoIP.

How to Configure Link Layer Discovery Protocol in Multivendor Networks

Enabling and Disabling LLDP Globally

LLDP is disabled globally by default. This section describes the tasks for enabling and disabling LLDP globally.

Enabling LLDP Globally

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**lldp** {**hold time** *seconds* | **reinit** *delay* | **run** | **timer** *rate* | **tlv-select** *tlv*} **Example:** `Device(config)# lldp run`	Enables LLDP globally.
Step 4	**end** **Example:** `Device(config)# end`	Returns to privileged EXEC mode.

Disabling LLDP Globally

Procedure

Step 1 **enable**

Example:

```
Device> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **configure terminal**

Example:

```
Device# configure terminal
```

Enters global configuration mode.

Step 3 **no lldp**{**hold time** *seconds* | **reinit** *delay* | **run** | **timer** *rate* | **tlv-select** *tlv*}

Example:

```
Device(config)# no lldp run
```

Disables LLDP globally.

Step 4 **end**

Example:

```
Device(config)# end
```

Returns to privileged EXEC mode.

Disabling and Enabling LLDP on a Supported Interface

LLDP is enabled by default on all supported interfaces. This section describes the tasks for disabling and enabling LLDP on a supported interface.

Disabling LLDP on a Supported Interface

Procedure

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.

	Command or Action	Purpose
Step 3	**interface** *type number* **Example:** `Device(config)# interface ethernet 0/1`	Specifies the interface type and number and enters interface configuration mode.
Step 4	**no lldp** {**tlv-select** *tlv* | **receive** | **transmit**} **Example:** `Device(config-if)# no lldp receive`	Disables an LLDP TLV or LLDP packet reception on a supported interface.
Step 5	**end** **Example:** `Device(config-if)# end`	Returns to privileged EXEC mode.

Enabling LLDP on a Supported Interface

LLDP information can be transmitted and received only on an interface where LLDP is configured and enabled. Perform this task to enable LLDP.

Procedure

Step 1 **enable**

Example:

```
Device> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **configure terminal**

Example:

```
Device# configure terminal
```

Enters global configuration mode.

Step 3 **interface** *type number*

Example:

```
Device(config)# interface ethernet 0/1
```

Specifies the interface type and number and enters interface configuration mode.

Step 4 **lldp** {**tlv-select** *tlv* | **receive** | **transmit**}

Example:

```
Device(config-if)# lldp transmit
```

Enables an LLDP TLV or LLDP packet transmission on a supported interface.

Step 5 **end**

Example:

```
Device(config-if)# end
```

Returns to privileged EXEC mode.

Setting LLDP Packet Hold Time

Hold time is the duration that a receiving device should maintain LLDP neighbor information before aging it. Perform this task to define a hold time for an LLDP-enabled device.

Procedure

Step 1 **enable**

Example:

```
Device> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **configure terminal**

Example:

```
Device# configure terminal
```

Enters global configuration mode.

Step 3 **lldp holdtime** *seconds*

Example:

```
Device(config)# lldp holdtime 100
```

Specifies the hold time.

Step 4 **end**

Example:

```
Device(config)# end
```

Returns to privileged EXEC mode.

Setting LLDP Packet Frequency

Perform this task to specify an interval at which the Cisco software sends LLDP updates to neighboring devices.

Procedure

Step 1 **enable**

Example:

```
Device> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **configure terminal**

Example:

```
Device# configure terminal
```

Enters global configuration mode.

Step 3 **lldp timer** *rate*

Example:

```
Device(config)# lldp timer 75
```

Specifies the rate at which LLDP packets are sent every second.

Step 4 **end**

Example:

```
Device(config)# end
```

Returns to privileged EXEC mode.

Monitoring and Maintaining LLDP in Multivendor Networks

Perform this task to monitor and maintain LLDP in multivendor networks. This task is optional, and Steps 2 and 3 can be performed in any sequence.

Procedure

Step 1 **enable**

Example:

```
Device> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **show lldp** [**entry** {***** | *word*} | **errors** | **interface** [**ethernet** *number*]| **neighbors** [**ethernet** *number*| **detail**]| **traffic**]

Example:

```
Device# show lldp entry *
```

Displays summarized and detailed LLDP information.

Note When the **show lldp neighbors** command is issued, if the device ID has more than 20 characters, the ID is truncated to 20 characters in command output because of display constraints.

Step 3 **clear lldp** {**counters** | **table**}

Example:

```
Device# clear lldp counters
```

Resets LLDP traffic counters and tables to zero.

Step 4 **end**

Example:

```
Device# end
```

Returns to user EXEC mode.

Enabling and Disabling LLDP TLVs

LLDP TLV support is enabled by default if LLDP is enabled globally and locally on a supported interface. Specific TLVs, however, can be enabled and suppressed.

Enabling LLDP TLVs

Procedure

Step 1 **enable**

Example:

```
Device> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **configure terminal**

Example:

```
Device# configure terminal
```

Enters global configuration mode.

Step 3 **interface** *type number*

Example:

```
Device(config)# interface ethernet 0/1
```

Specifies the interface type and number on which to enable LLDP and enters interface configuration mode.

Step 4 **lldp** {**tlv-select** *tlv* | **receive** | **transmit**}

Example:

```
Device(config-if)# lldp transmit
```

Enables an LLDP TLV or LLDP packet transmission on a supported interface.

Step 5 **lldp tlv-select** *tlv*

Example:

```
Device(config-if)# lldp tlv-select system-description
```

Enables a specific LLDP TLV on a supported interface.

Step 6 **end**

Example:

```
Device(config-if)# end
```

Returns to privileged EXEC mode.

Disabling LLDP TLVs

Procedure

Step 1 **enable**

Example:

```
Device> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **configure terminal**

Example:

```
Device# configure terminal
```

Enters global configuration mode.

Step 3 **interface** *type number*

Example:

```
Device(config)# interface ethernet 0/1
```

Specifies the interface type and number on which to disable LLDP and enters interface configuration mode.

Step 4 **no lldp** {**tlv-select** *tlv* | **receive** | **transmit**}

Example:

```
Device(config-if)# no lldp receive
```

Disables an LLDP TLV or LLDP packet reception on a supported interface.

Step 5 **no lldp tlv-select** *tlv*

Example:

```
Device(config-if)# no lldp tlv-select system-description
```

Disables a specific LLDP TLV on a supported interface.

Step 6 **end**

Example:

```
Device(config-if)# end
```

Returns to privileged EXEC mode.

Configuration Examples for Link Layer Discovery Protocol in Multivendor Networks

Example: Configuring Voice VLAN

The following example shows how to configure voice VLAN and verify

```
Device1> enable
Device1# configure terminal
Device1(config)# interface GigabitEthernet0/1/7
Device1(config-if)# switchport voice vlan 10
Device1(config-if)# no ip address
Device1(config-if)# end
```

The following example displays the updated running configuration on Device 2. LLDP is enabled with hold time, timer, and TLV options configured.

```
Device1# show lldp neighbors detail

Local Intf: Gi0/1/7
Chassis id: 10.10.0.1
Port id: C8F9F9D61BC2:P1
Port Description: SW PORT
System Name: SEPC8F9F9D61BC2

System Description:
Cisco IP Phone 7962G,V12, SCCP42.9-3-1ES27S

Time remaining: 127 seconds
System Capabilities: B,T
Enabled Capabilities: B,T
Management Addresses:
    IP: 10.10.0.1
Auto Negotiation - supported, enabled
Physical media capabilities:
    1000baseT(HD)
    1000baseX(FD)
    Symm, Asym Pause(FD)
    Symm Pause(FD)
Media Attachment Unit type: 16
Vlan ID: - not advertised

MED Information:

    MED Codes:
          (NP) Network Policy, (LI) Location Identification
          (PS) Power Source Entity, (PD) Power Device
          (IN) Inventory

    H/W revision: 12
    F/W revision: tnp62.8-3-1-21a.bin
    S/W revision: SCCP42.9-3-1ES27S
    Serial number: FCH1610A5S5
    Manufacturer: Cisco Systems, Inc.
    Model: CP-7962G
    Capabilities: NP, PD, IN
    Device type: Endpoint Class III
    Network Policy(Voice): VLAN 10, tagged, Layer-2 priority: 5, DSCP: 46
    Network Policy(Voice Signal): VLAN 10, tagged, Layer-2 priority: 4, DSCP: 32
    PD device, Power source: Unknown, Power Priority: Unknown, Wattage: 6.3
    Location - not advertised
```

The following example shows how to configure LLDP timer, hold time, and TLVs options on Device 2.

```
Device> enable
Device# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Device(config)# lldp run
Device(config)# lldp holdtime 150
Device(config)# lldp timer 15
Device(config)# lldp tlv-select port-vlan
Device(config)# lldp tlv-select mac-phy-cfg
Device2(config)# interface ethernet 0/0
Device2(config-if)# lldp transmit
Device2(config-if)# end
00:08:32: %SYS-5-CONFIG_I: Configured from console by console
```

The following example shows that voice vlan has been configured on the IP phone.

```
Device1# show lldp traffic
LLDP traffic statistics:
```

```
    Total frames out: 20
    Total entries aged: 0
    Total frames in: 15
    Total frames received in error: 0
    Total frames discarded: 0
    Total TLVs unrecognized: 0
Device1# show lldp neighbors
Capability codes:
    (R) Router, (B) Bridge, (T) Telephone, (C) DOCSIS Cable Device
    (W) WLAN Access Point, (P) Repeater, (S) Station, (O) Other
Device ID           Local Intf     Hold-time  Capability      Port ID
Device2             Et0/0          150        R               Et0/0
Total entries displayed: 1
Device2# show lldp traffic
LLDP traffic statistics:
    Total frames out: 15
    Total entries aged: 0
    Total frames in: 17
    Total frames received in error: 0
    Total frames discarded: 2
    Total TLVs unrecognized: 0
Device2# show lldp neighbors
Capability codes:
    (R) Router, (B) Bridge, (T) Telephone, (C) DOCSIS Cable Device
    (W) WLAN Access Point, (P) Repeater, (S) Station, (O) Other
Device ID           Local Intf     Hold-time  Capability      Port ID
Device1             Et0/0          150        R               Et0/0
Total entries displayed: 1
```

Tagged Packets Using Link Layer Discovery Protocol in Multivendor Networks

Table 1: Feature History

Feature Name	Release Information	Description
Tagged Packet Support Using Link Layer Discovery Protocol (LLDP)	Cisco IOS XE Dublin 17.10.1	LLDP now supports tagged packet transmission over a service instance with dot1q encapsulation. LLDP advertises information about themselves to their network neighbors, and store the information they discover from other devices. Though both these transmitted frames go through the same physical interface, they can be uniquely identified by the information advertised in the Port ID Type-Length-Value (TLV). You can use the lldp enable command to enable LLDP over a particular service instance. Use the **show lldp neighbors** and **show lldp entry** command outputs for neighboring device details. This feature is supported on both Cisco RSP2 and RSP3 modules.

LLDP packets are untagged, and they don't contain 802.1Q header information with VLAN identifier and priority tagging. Starting with Cisco IOS XE Dublin 17.10.1 release, LLDP packet transmission now supports tagged packets over a service instance with dot1q encapsulation. LLDP considers the interface and service instance as an individual entity and transmits the LLDP frames individually. A VLAN tag is added to the Ethernet LLDP frame, based on the encapsulation type of the service instance and sent via Ethernet interface.

An Ethernet flow point (EFP) service instance is a logical interface that connects a bridge domain to a physical port or to an Ether Channel. The neighbor discovery happens over a service instance with encapsulation type as dot1q, to advertise their identity, interconnections, and capabilities.

The **lldp enable** command supports LLDP frames traffic over a service instance. Use this command per service instance, and whenever there is a requirement to run LLDP over a service instance.

The existing commands, **lldp run** and **l2protocol peer lldp** under service instance, must be configured to initiate the LLDP process, along with **lldp enable** command to enable LLDP over a particular service instance.

Limitations and Restrictions

- Starting with Cisco IOS XE Dublin 17.10.1, LLDP supports tagged packets. Also, LLDP is still supported over untagged encapsulated service instance.

- The encapsulation untagged packets work, even without **lldp enable** command.
- For LLDP to receive packets, ensure to enable **l2protocol peer lldp** command with **lldp enable** command.

Configuration Example of LLDP in Service Instance

Example Enabling LLDP

The following example shows, how to enable LLDP in a service instance on tagged packets.

```
Router#configure terminal
Router(config)#lldp run
Router(config)#interface TenGigabitEthernet0/2/0
Router(config-if)#service instance 20 ethernet
Router(config-if-srv)#encapsulation dot1q 20
Router(config-if-srv)#l2protocol peer lldp
Router(config-if-srv)#lldp enable
Router(config-if-srv)#bridge-domain 20
Router(config-if-srv)#exit
```

Example Disabling LLDP

The following example shows, how to disable LLDP in a service instance on tagged packets.

```
Router#configure terminal
Router(config)#interface TenGigabitEthernet0/2/0
Router(config-if)#service instance 20 ethernet
Router(config-if-srv)#encapsulation dot1q 20
Router(config-if-srv)#no l2protocol peer lldp
Router(config-if-srv)#no lldp enable
Router(config-if-srv)#bridge-domain 20
Router(config-if-srv)#exit
```

Example Verifying LLDP

The following example shows the global LLDP details.

```
Router#show lldp
Global LLDP Information:
    Status: ACTIVE
    LLDP advertisements are sent every 30 seconds
    LLDP hold time advertised is 120 seconds
    LLDP interface reinitialisation delay is 2 seconds

Router#show lldp neighbor
Capability codes:
    (R) Router, (B) Bridge, (T) Telephone, (C) DOCSIS Cable Device
    (W) WLAN Access Point, (P) Repeater, (S) Station, (O) Other

Device ID           Local Intf     Hold-time  Capability      Port ID
CE1                 Te0/2/6        120        R               Te0/0/12
CE1                 Te0/2/1        120        R               Te0/0/15
CE1                 Te0/2/0        120        R               Te0/0/14
CE1                 Te0/2/0:2001   120        R               Te0/0/14.2001
CE1                 Te0/2/0:30     120        R               Te0/0/14.30
CE1                 Te0/2/0:2000   120        R               Te0/0/14.2000
CE1                 Te0/2/0:20     120        R               Te0/0/14.20 ------> lldp
neighbor learnt via service instance,
```

```
Port ID with service instance details
PE2                 Te0/2/3:20      120         R               Te0/8/3.20
PE2                 Te0/2/3:30      120         R               Te0/8/3.30
PE2                 Te0/2/3:1000    120         R               Te0/8/3.1000
PE2                 Te0/2/2         200         R               Te0/4/2
PE2                 Te0/2/5         120         R               Te0/8/5
PE2                 Te0/2/4         120         R               Te0/8/4
PE2                 Te0/2/3         120         R               Te0/8/3

Total entries displayed: 14

Router#show lldp interface TenGigabitEthernet0/2/0
TenGigabitEthernet0/2/0:
    Tx: enabled
    Rx: enabled
    Tx state: IDLE
    Rx state: WAIT FOR FRAME
    Enabled EFP: 2000 2001 20 30  ------> Displays the list of EFP's where lldp is enabled

Router#show lldp interface TenGigabitEthernet0/2/0 service-instance 20
TenGigabitEthernet0/2/0:
Service instance: 20 ------> Displays service instance details that is fetched
    Tx: enabled
    Rx: enabled
    Tx state: IDLE
    Rx state: WAIT FOR FRAME
```

Additional References for Using Link Layer Discovery Protocol in Multivendor Networks

Related Documents

Related Topic	Document Title
Cisco IOS commands: master list of commands with complete command syntax, command mode, command history, defaults, usage guidelines, and examples	*Cisco IOS Master Command List, All Releases*
Carrier Ethernet commands: complete command syntax, command mode, command history, defaults, usage guidelines, and examples	*Cisco IOS Carrier Ethernet Command Reference*
LLDP	*Link Layer Discovery Protocol*
Per port location configurations	*Per Port Location Configuration*

Standards and RFCs

Standards/RFCs	Title
IEEE 802.1ab	*Station and Media Access Control Connectivity Discovery*
RFC 2922	*Physical Topology MIB*

MIBs

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

Technical Assistance

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