



# CHAPTER 14

## Multiprotocol Label Switching

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This chapter describes the level of support that Cisco ANA provides for MPLS, as follows:

- [Technology Description, page 14-1](#)
- [Information Model Objects \(IMOs\), page 14-2](#)
- [Vendor-Specific Inventory and IMOs](#)
- [Network Topology, page 14-6](#)
- [Service Alarms, page 14-6](#)

### Technology Description

#### MPLS

MPLS was originally presented as a way of improving the forwarding speed of routers. It is now emerging as a crucial standard technology that offers new capabilities for large-scale IP networks. Traffic engineering (TE), the ability of network operators to dictate the path that traffic takes through the network, and VPN support, are examples of two key applications where MPLS is superior to any currently available IP technology. It integrates Layer 2 information about network links (bandwidth, latency, utilization) into Layer 3 (IP) within a particular autonomous system, or ISP, in order to simplify and improve IP packet exchange. It also gives network operators a great deal of flexibility in how they divert and route traffic around link failures, congestion, and bottlenecks.

When packets enter an MPLS-based network, label edge routers (LERs) give them a label identifier. These labels not only contain information based on the routing table entries (for example, destination, bandwidth, delay, and other metrics), but also refer to the IP header field (source IP address), Layer 4 socket number information, and differentiated service. Once this classification is complete and mapped, different packets are assigned to corresponding label switched paths (LSPs), where label switch routers (LSRs) place outgoing labels on the packets.

# LDP

Label Distribution Protocol (LDP) enables neighboring provider or provider-edge routers acting as LSRs in an MPLS-aware network to exchange label prefix binding information, which is required for forwarding traffic. The LSRs discover potential peers in the network with which they can establish LDP sessions in order to negotiate and exchange the labels (addresses) to be used for forwarding packets.

LDP supports two types of peer discovery:

- Basic discovery—Used to discover directly connected LDP LSRs. An LSR sends hello messages to the “all routers on this subnet” multicast address, on interfaces for which LDP has been configured.
- Extended discovery—Used between indirectly connected LDP LSRs. An LSR sends targeted hello messages to specific IP addresses. Targeted sessions must be configured since the routers are not physically connected and broadcasting would not reach the peers. The IP addresses of both peers are required for extended discovery.

# Information Model Objects (IMOs)

This section describes the following IMOs:

- [MPLS Interface \(IMpls\)](#)
- [Label Switching Entity \(ILse\)](#)
- [Equivalent Label Switching Entry \(ILSEEntries\)](#)
- [MPLS Entry \(IMplsEntry\)](#)
- [MPLS Aggregate Entry \(IMplsAggregateEntry\)](#)
- [LDP Service \(ILdpService\)](#)
- [LDP Peer \(ILdpPeer\)](#)
- [LDP Peer Discovery Source \(ILdpPeerDiscoverySource\)](#)

# MPLS Interface

The network/data link layer [MPLS Interface](#) object represents an MPLS configuration in a router interface. It is bound by its Containing Termination Points attribute to a data link layer interface object, and is accessed primarily by the Network layer [IP Interface](#) bound by its Contained Connection Termination Points attribute. It is also accessed by the [Label Switching Entity](#).

Table 14-1 MPLS Interface (IMpls)

| Attribute Name                  | Attribute Description                                                 | Scheme | Polling Interval |
|---------------------------------|-----------------------------------------------------------------------|--------|------------------|
| Distribution Protocol           | Distribution protocol ( <i>Null, LDP, TDP, RSVP, TDP and LDP</i> )    | IPCore | Configuration    |
| Outer and Inner Labels          | Outer and inner labels for Path Tracer                                | IPCore | Configuration    |
| Traffic Engineering Properties  | Traffic engineering properties ( <a href="#">MPLS TE Properties</a> ) | IPCore | Configuration    |
| Resource Reservation Properties | Resource Reservation Protocol properties                              | IPCore | Configuration    |

**Table 14-1** *MPLS Interface (IMpls) (continued)*

| Attribute Name                          | Attribute Description                                           | Scheme | Polling Interval |
|-----------------------------------------|-----------------------------------------------------------------|--------|------------------|
| IANA Type                               | Internet Assigned Numbers Authority (IANA) type of the sublayer | N/A    | N/A              |
| Containing Termination Points           | Underlying termination points (connection or physical)          | IPCore | N/A              |
| Contained Connection Termination Points | Bound connection termination points                             | IPCore | N/A              |

## Label Switching Entity

The [Label Switching Entity](#) object describes the protocol-independent forwarding component of an LSR. It is bound by its Logical Sons attribute to all the network or data link layer [MPLS Interface](#) objects among which this [Label Switching Entity](#) is switching IP packets.

**Table 14-2** *Label Switching Entity (ILse)*

| Attribute Name       | Attribute Description                                                                                                          | Scheme | Polling Interval |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------|--------|------------------|
| MPLS Table           | Array of <a href="#">Equivalent Label Switching Entries</a> between MPLS interfaces                                            | IPCore | Configuration    |
| MPLS Aggregate Table | Array of <a href="#">Equivalent Label Switching Entries</a> from MPLS interfaces into VRF tables                               | IPCore | Configuration    |
| MPLS Tunnel Segments | Array of switched MPLS TE tunnel segments (GUI usage) (see <a href="#">Multiprotocol Label Switching Traffic Engineering</a> ) | IPCore | Configuration    |
| LDP Service          | <a href="#">LDP Service</a> which holds the <a href="#">LDP Peers</a>                                                          | IPCore | Configuration    |
| Logical Sons         | Array of all <a href="#">MPLS Interfaces</a> among which this <a href="#">Label Switching Entity</a> is switching IP packets   | IPCore | N/A              |

## Equivalent Label Switching Entry

The [Equivalent Label Switching Entry](#), [MPLS Entry](#), and [MPLS Aggregate Entry](#) objects describe an MPLS Label Switching table's entries. Each is an array of [MPLS Entries](#) or [MPLS Aggregate Entries](#) sharing a single ingress label.

**Table 14-3** *Equivalent Label Switching Entry (ILSEEntries)*

| Attribute Name          | Attribute Description                                                                                                   | Scheme | Polling Interval |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------|--------|------------------|
| Label Switching Entries | Array of either <a href="#">MPLS Entries</a> or <a href="#">MPLS Aggregate Entries</a> (sharing a single ingress label) | IPCore | Configuration    |

## MPLS Entry

**Table 14-4** *MPLS Entry (IMplsEntry)*

| Attribute Name               | Attribute Description                                                      | Scheme | Polling Interval |
|------------------------------|----------------------------------------------------------------------------|--------|------------------|
| Incoming Label               | Incoming label                                                             | IPCore | Configuration    |
| Outgoing Interface and Label | Outgoing interface and label                                               | IPCore | Configuration    |
| Switching Action             | Switching action ( <i>Null, Pop, Swap, Aggregate, Untagged, Pop, Act</i> ) | IPCore | Configuration    |
| Next Hop IP Address          | Next hop IP address                                                        | IPCore | Configuration    |
| Destination Mask             | IP subnet mask of the destination                                          | IPCore | Configuration    |
| Destination Address          | Destination IP address                                                     | IPCore | Configuration    |

## MPLS Aggregate Entry

**Table 14-5** *MPLS Aggregate Entry (IMplsAggregateEntry)*

| Attribute Name               | Attribute Description                                                      | Scheme | Polling Interval |
|------------------------------|----------------------------------------------------------------------------|--------|------------------|
| Virtual Routing Entity       | Virtual Routing and Forwarding (VRF) entity                                | IPCore | Configuration    |
| Incoming Label               | Incoming label                                                             | IPCore | Configuration    |
| Outgoing Interface and Label | Outgoing interface and label                                               | IPCore | Configuration    |
| Switching Action             | Switching action ( <i>Null, Pop, Swap, Aggregate, Untagged, Pop, Act</i> ) | IPCore | Configuration    |
| Next Hop IP Address          | Next hop IP address                                                        | IPCore | Configuration    |

## LDP Service

The [LDP Service](#) object, which is used in MPLS network environments, describes the main attributes of the LDP service. It is accessed only by the [Label Switching Entity](#)'s LDP Service attribute.

**Table 14-6** *LDP Service (ILdpService)*

| Attribute Name       | Attribute Description                            | Scheme | Polling Interval |
|----------------------|--------------------------------------------------|--------|------------------|
| Local Identification | Local LDP identifier                             | IPCore | Configuration    |
| Status               | Service status ( <i>Unknown, Running, Down</i> ) | IPCore | Configuration    |
| LDP Peers            | Array of <a href="#">LDP Peers</a>               | IPCore | Configuration    |

## LDP Peer

The [LDP Peer](#) object describes a remote LDP entity that currently has an LDP session with the Local [LDP Service](#). The LDP Peer is bound to the LDP Service by the latter's LDP Peer attribute.

**Table 14-7** *LDP Peer (ILdpPeer)*

| Attribute Name         | Attribute Description                                                                            | Scheme | Polling Interval |
|------------------------|--------------------------------------------------------------------------------------------------|--------|------------------|
| Peer Identification    | Peer LDP identifier                                                                              | IPCore | Configuration    |
| Transport Addresses    | Peer transport IP addresses                                                                      | IPCore | Configuration    |
| Distribution Method    | Label distribution method ( <i>Unknown, Downstream, Downstream On Demand</i> )                   | IPCore | Configuration    |
| Protocol Type          | Peer protocol type ( <i>Unknown, LDP, TDP</i> )                                                  | IPCore | Configuration    |
| Path Vector Limit      | Path vector limit for loop detection                                                             | IPCore | Configuration    |
| Session Status         | LDP session status type ( <i>Transient, Initialized, Open Received, Open Sent, Operational</i> ) | IPCore | Configuration    |
| Protocol Version       | LDP session protocol version                                                                     | IPCore | Configuration    |
| Hold Time              | Hold time for maintaining the session without receiving traffic or keepalive                     | IPCore | Configuration    |
| Hello Time Interval    | Time interval at which hello ( <i>Keep Alive</i> ) packets should be sent                        | IPCore | Configuration    |
| Peer Discovery Sources | Array of <a href="#">LDP Peer Discovery Sources</a>                                              | IPCore | Configuration    |

## LDP Peer Discovery Source

The [LDP Peer Discovery Source](#) object describes the discovery source of the LDP Peer. Identification of the Peer is done using broadcast on [MPLS Interfaces](#) and a hello message exchanged between LSRs.

**Table 14-8** *LDP Peer Discovery Source (ILdpPeerDiscoverySource)*

| Attribute Name   | Attribute Description                                     | Scheme | Polling Interval |
|------------------|-----------------------------------------------------------|--------|------------------|
| Interface Name   | MPLS interface name on which the peer was discovered      | IPCore | Configuration    |
| Source Addresses | Source IP addresses from which the hello message was sent | IPCore | Configuration    |
| Type             | Discovery type ( <i>Link, Targeted</i> )                  | IPCore | Configuration    |

# Vendor-Specific Inventory and IMOs

There are no vendor-specific inventory or IMOs for this technology.

## Network Topology

Cisco ANA discovers MPLS network layer topology by searching for the existence of the local IP subnet in any one-hop-away remote side's [MPLS Interface](#). In particular, it compares the local and remote IP subnets gathered from the upper IP network layers.

## Service Alarms

The following alarms are supported for this technology:

- Broken LSP Discovered
- MPLS Black Hole Found/MPLS Black Hole Cleared
- MPLS Interface Removed/MPLS Interface Added
- LDP Neighbor Down/LDP Neighbor Up

For detailed information about alarms and correlation, see the [Cisco Active Network Abstraction 3.7 User Guide](#).