CHAPTER 15

Multiprotocol Label Switching

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

Technology Description

This section provides the following MPLS technology descriptions:

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

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 15-1 MPLS Interface (IMpls)

Attribute Name	Attribute Description	Scheme	Polling Interval
Distribution Protocol	Distribution protocol (*Null, LDP, TDP, RSVP, TDP and LDP*)	IPCore	Configuration
Outer and Inner Labels	Outer and inner labels for Path Tracer	IPCore	Configuration
Traffic Engineering Properties	Traffic engineering properties (MPLS TE Properties)	IPCore	Configuration
Resource Reservation Properties	Resource Reservation Protocol properties	IPCore	Configuration

Table 15-1 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 15-2 Label Switching Entity (ILse)

Attribute Name	Attribute Description	Scheme	Polling Interval
MPLS Table	Array of Equivalent Label Switching Entries between MPLS interfaces	IPCore	Configuration
MPLS Aggregate Table	Array of Equivalent Label Switching Entries from MPLS interfaces into VRF tables	IPCore	Configuration
MPLS Tunnel Segments	Array of switched MPLS TE tunnel segments (GUI usage) (see Multiprotocol Label Switching Traffic Engineering)	IPCore	Configuration
LDP Service	LDP Service which holds the LDP Peers	IPCore	Configuration
Logical Sons	Array of all MPLS Interfaces among which this Label Switching Entity 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 15-3 Equivalent Label Switching Entry (ILSEEntries)

Attribute Name	Attribute Description	Scheme	Polling Interval
Label Switching Entries	Array of either MPLS Entries or MPLS Aggregate Entries (sharing a single ingress label)	IPCore	Configuration

MPLS Entry

Table 15-4 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 (*Null, Pop, Swap, Aggregate, Untagged, Pop, Act*)	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 15-5 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 (*Null, Pop, Swap, Aggregate, Untagged, Pop, Act*)	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 15-6 LDP Service (ILdpService)

Attribute Name	Attribute Description	Scheme	Polling Interval
Local Identification	Local LDP identifier	IPCore	Configuration
Status	Service status (*Unknown, Running, Down*)	IPCore	Configuration
LDP Peers	Array of LDP Peers	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 15-7 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 (*Unknown, Downstream, Downstream On Demand*)	IPCore	Configuration
Protocol Type	Peer protocol type (*Unknown, LDP, TDP*)	IPCore	Configuration
Path Vector Limit	Path vector limit for loop detection	IPCore	Configuration
Session Status	LDP session status type (*Transient, Initialized, Open Received, Open Sent, Operational*)	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 (*Keep Alive*) packets should be sent	IPCore	Configuration
Peer Discovery Sources	Array of LDP Peer Discovery Sources	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 15-8 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 (*Link, Targeted*)	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, page 41-11
- MPLS Black Hole Found, page 41-47
- MPLS Interface Removed, page 41-48
- LDP Neighbor Loss, page 41-41