



Configuring Multiprotocol Label Switching (MPLS)

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Multiprotocol Label Switching

This module describes Multiprotocol Label Switching and how to configure it on Cisco switches.

Restrictions for Multiprotocol Label Switching

- Multiprotocol Label Switching (MPLS) fragmentation is not supported.
- MPLS maximum transmission unit (MTU) is not supported.

Information about Multiprotocol Label Switching

Multiprotocol label switching (MPLS) combines the performance and capabilities of Layer 2 (data link layer) switching with the proven scalability of Layer 3 (network layer) routing. MPLS enables you to meet the challenges of explosive growth in network utilization while providing the opportunity to differentiate services without sacrificing the existing network infrastructure. The MPLS architecture is flexible and can be employed in any combination of Layer 2 technologies. MPLS support is offered for all Layer 3 protocols, and scaling is possible well beyond that typically offered in today's networks.

Functional Description of Multiprotocol Label Switching

Label switching is a high-performance packet forwarding technology that integrates the performance and traffic management capabilities of data link layer (Layer 2) switching with the scalability, flexibility, and performance of network layer (Layer 3) routing.

Label Switching Functions

In conventional Layer 3 forwarding mechanisms, as a packet traverses the network, each switch extracts all the information relevant to forwarding the packet from the Layer 3 header. This information is then used as an index for a routing table lookup to determine the next hop for the packet.

In the most common case, the only relevant field in the header is the destination address field, but in some cases, other header fields might also be relevant. As a result, the header analysis must be done independently at each switch through which the packet passes. In addition, a complicated table lookup must also be done at each switch.

In label switching, the analysis of the Layer 3 header is done only once. The Layer 3 header is then mapped into a fixed length, unstructured value called a *label*.

Many different headers can map to the same label, as long as those headers always result in the same choice of next hop. In effect, a label represents a *forwarding equivalence class*--that is, a set of packets which, however different they may be, are indistinguishable by the forwarding function.

The initial choice of a label need not be based exclusively on the contents of the Layer 3 packet header; for example, forwarding decisions at subsequent hops can also be based on routing policy.

Once a label is assigned, a short label header is added at the front of the Layer 3 packet. This header is carried across the network as part of the packet. At subsequent hops through each MPLS switch in the network, labels are swapped and forwarding decisions are made by means of MPLS forwarding table lookup for the label carried in the packet header. Hence, the packet header does not need to be reevaluated during packet transit through the network. Because the label is of fixed length and unstructured, the MPLS forwarding table lookup process is both straightforward and fast.

Distribution of Label Bindings

Each label switching router (LSR) in the network makes an independent, local decision as to which label value to use to represent a forwarding equivalence class. This association is known as a label binding. Each LSR informs its neighbors of the label bindings it has made. This awareness of label bindings by neighboring switches is facilitated by the following protocols:

- Label Distribution Protocol (LDP)--enables peer LSRs in an MPLS network to exchange label binding information for supporting hop-by-hop forwarding in an MPLS network
- Border Gateway Protocol (BGP)--Used to support MPLS virtual private networks (VPNs)

When a labeled packet is being sent from LSR A to the neighboring LSR B, the label value carried by the IP packet is the label value that LSR B assigned to represent the forwarding equivalence class of the packet. Thus, the label value changes as the IP packet traverses the network.

For more information about LDP configuration, see the see MPLS: LDP Configuration Guide at http://www.cisco.com/c/en/us/td/docs/ios-xml/ios/mppls/config_library/xe-3s/mp-xe-3s-library.html



Note

As the scale of label entries is limited in, especially with ECMP, it is recommended to enable LDP label filtering. LDP labels shall be allocated only for well known prefixes like loopback interfaces of routers and any prefix that needs to be reachable in the global routing table.

MPLS Layer 3 VPN

A Multiprotocol Label Switching (MPLS) Virtual Private Network (VPN) consists of a set of sites that are interconnected by means of an MPLS provider core network. At each customer site, one or more customer edge (CE) routers attach to one or more provider edge (PE) routers.

Before configuring MPLS Layer 3 VPNs, you should have MPLS, Label Distribution Protocol (LDP), and Cisco Express Forwarding (CEF) installed in your network. All routers in the core, including the PE routers, must be able to support CEF and MPLS forwarding.

Classifying and Marking MPLS QoS EXP

The QoS EXP Matching feature allows you to classify and mark network traffic by modifying the Multiprotocol Label Switching (MPLS) experimental bits (EXP) field in IP packets.

The QoS EXP Matching feature allows you to organize network traffic by setting values for the MPLS EXP field in MPLS packets. By choosing different values for the MPLS EXP field, you can mark packets so that packets have the priority that they require during periods of congestion. Setting the MPLS EXP value allows you to:

- **Classify traffic:** The classification process selects the traffic to be marked. Classification accomplishes this by partitioning traffic into multiple priority levels, or classes of service. Traffic classification is the primary component of class-based QoS provisioning.
- **Police and mark traffic:** Policing causes traffic that exceeds the configured rate to be discarded or marked to a different drop level. Marking traffic is a way to identify packet flows to differentiate them. Packet marking allows you to partition your network into multiple priority levels or classes of service.

Restrictions

Following is the list of restrictions for classifying and marking MPLS QoS EXP:

- Only Uniform mode and Pipe mode are supported; Short-pipe mode is not supported.
- Support range of QoS-group values range between 0 and 30. (Total 31 QoS-groups).
- EXP marking using QoS policy is supported only on the outer label; inner EXP marking is not supported.

How to Configure Multiprotocol Label Switching

This section explains how to perform the basic configuration required to prepare a switch for MPLS switching and forwarding.

Configuring a Switch for MPLS Switching (CLI)

MPLS switching on Cisco switches requires that Cisco Express Forwarding be enabled.



Note `ip unnumbered` command is not supported in MPLS configuration.

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	ip cef distributed Example: Device(config)# ip cef distributed	Enables Cisco Express Forwarding on the switch.
Step 4	mpls label range <i>minimum-value</i> <i>maximum-value</i> Example: Device(config)# mpls label range 16 4096	Configure the range of local labels available for use with MPLS applications on packet interfaces.
Step 5	mpls label protocol ldp Example: Device(config)# mpls label protocol ldp	Specifies the label distribution protocol for the platform.

Configuring a Switch for MPLS Forwarding (CLI)

MPLS forwarding on Cisco switches requires that forwarding of IPv4 packets be enabled.



Note **ip unnumbered** command is not supported in MPLS configuration.

Procedure

	Command or Action	Purpose
Step 1	enable Example: Device> enable	Enables privileged EXEC mode. Enter your password, if prompted.

	Command or Action	Purpose
Step 2	configure terminal Example: Device# configure terminal	Enters global configuration mode.
Step 3	interface type slot/subslot /port Example: Device(config)# interface gigabitethernet 1/0/0	Specifies the Gigabit Ethernet interface and enters interface configuration mode. For Switch Virtual Interface (SVI), the example is Device(config)# interface vlan 1000
Step 4	mpls ip Example: Device(config-if)# mpls ip	Enables MPLS forwarding of IPv4 packets along routed physical interfaces (Gigabit Ethernet), Switch Virtual Interface (SVI), or port channels.
Step 5	mpls label protocol ldp Example: Device(config-if)# mpls label protocol ldp	Specifies the label distribution protocol for an interface. Note MPLS LDP cannot be enabled on a Virtual Routing and Forwarding (VRF) interface.
Step 6	end Example: Device(config-if)# end	Exits interface configuration mode and returns to privileged EXEC mode.

Verifying Multiprotocol Label Switching Configuration

This section explains how to verify successful configuration of MPLS switching and forwarding.

Verifying Configuration of MPLS Switching

To verify that Cisco Express Forwarding has been configured properly, issue the **show ip cef summary** command, which generates output similar to that shown below:

Procedure

```
show ip cef summary
```

Example:

```
Switch# show ip cef summary

IPv4 CEF is enabled for distributed and running
```

```

VRF Default
 150 prefixes (149/1 fwd/non-fwd)
 Table id 0x0
 Database epoch:      4 (150 entries at this epoch)
 Switch#

```

Verifying Configuration of MPLS Forwarding

To verify that MPLS forwarding has been configured properly, issue the **show mpls interfaces detail** command, which generates output similar to that shown below:



Note The MPLS MTU value is equivalent to the IP MTU value of the port or switch by default. MTU configuration for MPLS is not supported.

Procedure

Step 1 show mpls interfaces detail

Example:

For physical (Gigabit Ethernet) interface:
Switch# **show mpls interfaces detail interface GigabitEthernet 1/0/0**

```

Type Unknown
IP labeling enabled
LSP Tunnel labeling not enabled
IP FRR labeling not enabled
BGP labeling not enabled
MPLS not operational
MTU = 1500

```

For Switch Virtual Interface (SVI):
Switch# **show mpls interfaces detail interface Vlan1000**

```

Type Unknown
IP labeling enabled (ldp) :
  Interface config
LSP Tunnel labeling not enabled
IP FRR labeling not enabled
BGP labeling not enabled
MPLS operational
MTU = 1500

```

Step 2 show running-config interface

Example:

For physical (Gigabit Ethernet) interface:
Switch# **show running-config interface interface GigabitEthernet 1/0/0**

Building configuration...

```

Current configuration : 307 bytes
!
interface TenGigabitEthernet1/0/0
no switchport
ip address xx.xx.x.x xxx.xxx.xxx.x
mpls ip
mpls label protocol ldp
end

```

For Switch Virtual Interface (SVI):
Switch# **show running-config interface interface Vlan1000**

Building configuration...

```

Current configuration : 187 bytes
!
interface Vlan1000
ip address xx.xx.x.x xxx.xxx.xxx.x
mpls ip
mpls label protocol ldp
end

```

Step 3 show mpls forwarding

Example:

For physical (Gigabit Ethernet) interface:

```

Switch#show mpls forwarding-table
Local   Outgoing   Prefix           Bytes Label   Outgoing   Next Hop
Label   Label      or Tunnel Id     Switched      interface
500     No Label   12ckt(3)         0             Gi3/0/22   point2point
501     No Label   12ckt(1)         12310411816789 none         point2point
502     No Label   12ckt(2)         0             none        point2point
503     566       15.15.15.15/32  0             Po5         192.1.1.2
504     530       7.7.7.7/32      538728528    Po5         192.1.1.2
505     573       6.6.6.10/32     0             Po5         192.1.1.2
506     606       6.6.6.6/32      0             Po5         192.1.1.2
507     explicit-n 1.1.1.1/32      0             Po5         192.1.1.2
556     543       19.10.1.0/24    0             Po5         192.1.1.2
567     568       20.1.1.0/24     0             Po5         192.1.1.2
568     574       21.1.1.0/24     0             Po5         192.1.1.2
574     No Label   213.1.1.0/24[V] 0             aggregate/vpn113
575     No Label   213.1.2.0/24[V] 0             aggregate/vpn114
576     No Label   213.1.3.0/24[V] 0             aggregate/vpn115
577     No Label   213:1:1::/64    0             aggregate
594     502       103.1.1.0/24    0             Po5         192.1.1.2
595     509       31.1.1.0/24     0             Po5         192.1.1.2
596     539       15.15.1.0/24    0             Po5         192.1.1.2
597     550       14.14.1.0/24    0             Po5         192.1.1.2
633     614       2.2.2.0/24      0             Po5         192.1.1.2
634     577       90.90.90.90/32  873684       Po5         192.1.1.2
635     608       154.1.1.0/24    0             Po5         192.1.1.2
636     609       153.1.1.0/24    0             Po5         192.1.1.2
Switch#
end

```

