



# Configuring MPLS Quality of Service

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This chapter describes how to configure Multiprotocol Label Switching (MPLS) quality of service (QoS) on Cisco NX-OS devices.

This chapter includes the following sections:

- [Finding Feature Information, page 19-304](#)
- [Information About MPLS QoS, page 19-305](#)
- [Licensing Requirements for MPLS QoS, page 19-315](#)
- [Prerequisites for MPLS QoS, page 19-315](#)
- [Guidelines and Limitations for MPLS QoS, page 19-315](#)
- [Default Settings for MPLS QoS, page 19-317](#)
- [Configuring MPLS QoS, page 19-318](#)
- [Verifying the MPLS QoS Configuration, page 19-323](#)
- [Configuration Examples for MPLS QoS, page 19-323](#)
- [Additional References for MPLS QoS, page 19-325](#)
- [Feature History for MPLS QoS, page 19-325](#)

## Finding Feature Information

Your software release might not support all the features documented in this module. For the latest caveats and feature information, see the Bug Search Tool at <https://tools.cisco.com/bugsearch/> and the release notes for your software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the “New and Changed Information” chapter or the Feature History table below.

# Information About MPLS QoS

MPLS QoS enables you to provide differentiated types of service across an MPLS network. Differentiated types of service satisfy a range of requirements by supplying the service specified for each packet.

**Note**

QoS allows you to classify the network traffic, police and prioritize the traffic flow, and provide congestion avoidance. For general information about QoS in Cisco NX-OS, see the *Cisco Nexus 7000 Series NX-OS Quality of Service Configuration Guide, Release 6.x*.

This section includes the following topics:

- [MPLS QoS Terminology, page 19-305](#)
- [MPLS QoS Features, page 19-306](#)
- [MQC CLI, page 19-308](#)
- [Topology and Roles, page 19-308](#)
- [MPLS QoS Classification at the Edges and the Core, page 19-310](#)
- [MPLS DiffServ Tunneling Modes, page 19-314](#)
- [MPLS QoS and HA, page 19-315](#)

## MPLS QoS Terminology

This section defines some MPLS QoS terminology:

- *Class of Service* (CoS) refers to three bits in an 802.1Q header that are used to indicate the priority of the Ethernet frame as it passes through a switched network. The CoS bits in the 802.1Q header are commonly referred to as the 802.1p bits. To maintain QoS when a packet traverses both Layer 2 and Layer 3 domains, the type of service (ToS) and CoS values can be mapped to each other.
- *Classification* is the process used for selecting traffic to be marked for QoS.
- *Differentiated Services Code Point* (DSCP) is the first six bits of the ToS byte in the IP header. DSCP is only present in an IP packet.
- *Disposition* is the process of removing or popping one or more MPLS labels by the edge label switch router (LSR) when the packet is leaving an MPLS domain.
- *E-LSP* is a label switched path (LSP) on which nodes infer the QoS treatment for MPLS packets exclusively from the experimental (EXP) bits in the MPLS header. Because the QoS treatment is inferred from the EXP (both class and drop precedence), several classes of traffic can be multiplexed onto a single LSP (use the same label). A single LSP can support up to eight classes of traffic because the EXP field is a 3-bit field.
- *EXP bits* define the QoS treatment (per-hop behavior) that a node should give to a packet. It is the equivalent of the DiffServ Code Point (DSCP) in the IP network. A DSCP defines a class and drop precedence. The EXP bits are generally used to carry all the information encoded in the IP DSCP. In some cases, however, the EXP bits are used exclusively to encode the dropping precedence.
- *Frames* carry traffic at Layer 2. Layer 2 frames carry Layer 3 packets.
- *IP precedence* is the three most significant bits of the ToS byte in the IP header.

- Imposition is the process of adding or imposing one or more MPLS labels by the edge LSR when the packet is entering an MPLS domain.
- *QoS tags* are prioritization values carried in Layer 3 packets and Layer 2 frames. A Layer 2 CoS label can have a value ranging between zero for low priority and seven for high priority. A Layer 3 IP precedence label can have a value ranging between zero for low priority and seven for high priority. IP precedence values are defined by the three most significant bits of the 1-byte ToS byte. A Layer 3 DSCP label can have a value between 0 and 63. DSCP values are defined by the six most significant bits of the 1-byte IP ToS field.
- *LERs* (label edge routers) are devices that impose and dispose of labels upon packets; LERs are also referred to as Provider Edge (PE) routers.
- *LSRs* (label switching routers) are devices that forward traffic based upon labels present in a packet; LSRs are also referred to as Provider (P) routers.
- *Marking* is the process of setting a Layer 3 DSCP value in a packet. Marking is also the process of choosing different values for the MPLS EXP field to mark packets so that they have the priority that they require during periods of congestion.
- *MQC* is the Cisco Modular QoS command line interface (MQC) framework, which is a modular and highly extensible framework for deploying QoS.
- *Packets* carry traffic at Layer 3.
- *Policing* is limiting bandwidth used by a flow of traffic. Policing can mark or drop traffic.
- Swapping is the process of replacing one or more MPLS labels by the LSR within an MPLS domain.

## MPLS QoS Features

These topics describe the following MPLS QoS features that are supported in an MPLS network:

- [MPLS Experimental Field, page 19-306](#)
- [Trust, page 19-307](#)
- [Classification, page 19-307](#)
- [Policing and Marking, page 19-307](#)
- [Preserving IP ToS, page 19-307](#)
- [EXP Mutation, page 19-307](#)
- [MPLS DiffServ Tunneling, page 19-307](#)

## MPLS Experimental Field

Setting the MPLS experimental (EXP) field value satisfies the requirement of operators who do not want the value of the IP precedence field modified within IP packets transported through their networks.

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.

By default, the three most significant bits of the DSCP are copied into the MPLS EXP field during imposition. You can mark the MPLS EXP bits with an MPLS QoS policy.

## Trust

For received Layer 2 or Layer 3 MPLS packets, the router usually trusts the EXP value in the received topmost label. None of the following have any effect on MPLS packets:

- Interface trust state
- Port CoS value

## Classification

Classification is the process that selects the traffic to be marked. Classification partitions traffic into multiple priority levels or classes of service. Traffic classification is the primary component of class-based QoS provisioning. The router makes classification decisions based on the EXP bits in the received topmost label of the received MPLS packets (after a policy is installed). For more information, see the [“Configuring a Class Map to Classify MPLS Packets” section on page 19-319](#).

## Policing and Marking

Policing causes traffic that exceeds the configured rate to be discarded or marked down to a higher drop precedence. Marking 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.

The MPLS QoS policing and marking features that you can implement depend on the received traffic type and the forwarding operation applied to the traffic. See the [“Configuring a Policy Map” section on page 19-319](#) for information.

## Preserving IP ToS

The router automatically preserves the IP type of service (ToS) during all MPLS operations including imposition, swapping, and disposition. You do not need to enter a command to save the IP ToS.

## EXP Mutation

You can configure a named egress EXP mutation map to mutate the internal DSCP-derived EXP value before it is used as the egress EXP value. You can attach egress EXP mutation maps to these interface types:

- LAN port subinterfaces
- Layer 3 VLAN interfaces
- Layer 3 LAN ports

You cannot attach egress EXP mutation maps to these interface types:

- Layer 2 LAN ports (ports that are configured with the **switchport** command)

## MPLS DiffServ Tunneling

The router uses MPLS DiffServ tunneling to provide QoS transparency from one edge of a network to the other edge of the network. See the [“MPLS DiffServ Tunneling Modes” section on page 19-314](#) for more information.

## MQC CLI

All policing and marking features available for MPLS QoS are managed from the modular QoS command-line interface (CLI). The modular QoS CLI (MQC) allows you to define traffic classes (class maps), create and configure traffic policies (policy maps), and then attach those traffic policies to interfaces.



### Note

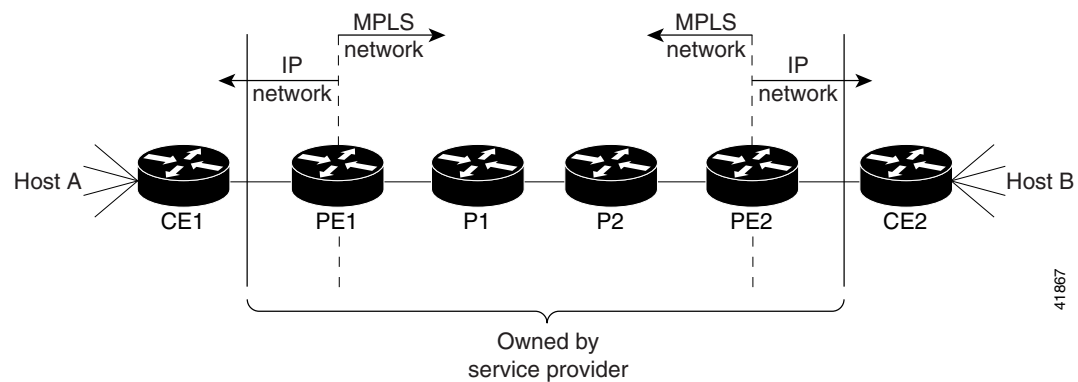
For detailed information on configuring QoS in NX-OS using the MQC, see the *Cisco Nexus 7000 Series NX-OS Quality of Service Configuration Guide, Release 6.x*.

## Topology and Roles

This section describes the roles of network devices in implementing MPLS QoS.

Figure 19-1 shows an MPLS network of a service provider that connects two sites of a customer network.

**Figure 19-1 MPLS Network Connecting Two Sites of a Customer's IP Network**



The network is bidirectional, but for the purpose of this document, the packets move left to right.

In Figure 19-1, the symbols have the following meanings:

- CE1—Customer equipment 1
- PE1—Service provider ingress LER
- P1—LSR within the core of the network of the service provider
- P2—LSR within the core of the network of the service provider
- PE2—Service provider egress LER
- CE2—Customer equipment 2



### Note

PE1 and PE2 are at the boundaries between the MPLS network and the IP network.

This section includes the following topics:

- [LERs at the Ingress Edge of an MPLS Network, page 19-309](#)
- [LSRs at the Core of an MPLS Network, page 19-309](#)

- [LERs at the Egress Edge of an MPLS Network, page 19-310](#)

## LERs at the Ingress Edge of an MPLS Network



### Note

Incoming labels are aggregate or nonaggregate. The aggregate label indicates that the arriving MPLS or MPLS VPN packet must be switched through an IP lookup to find the next hop and the outgoing interface. The nonaggregate label indicates that the packet contains the IP next-hop information.

At the ingress edge of an MPLS network, LERs process packets as follows:

1. Layer 2 or Layer 3 traffic enters the edge of the MPLS network at the edge LER (PE1).
2. The router receives the traffic from the input interface and uses the 802.1p bits or the IP ToS bits to perform any classification, marking, and policing to derive the new EXP bits. For classification of incoming IP packets, the input service policy can also use access control lists (ACLs).
3. For each incoming packet, the router performs a lookup on the IP address to determine the next-hop router.
4. The appropriate label is pushed (imposition) into the packet, and the EXP value resulting from the QoS decision is copied into the MPLS EXP field in the label header.
5. The router forwards the labeled packets to the appropriate output interface for processing.
6. The router also forwards the 802.1p bits or the IP ToS bits to the output interface. The 802.1p bits or the IP ToS bits can be remarked by EXP bits in the topmost label.
7. The labeled packets (marked by EXP) are sent to the core MPLS network.

## LSRs at the Core of an MPLS Network

At the core of an MPLS network, LSRs process packets as follows:

1. Incoming MPLS-labeled packets (and 802.1p bits or IP ToS bits) from an edge LER (or other core device) arrive at the core LSR.
2. The router receives the traffic from the input interface and uses the EXP bits to perform classification, marking, and policing.
3. The router performs a table lookup to determine the next-hop LSR.
4. An appropriate label is placed (swapped) into the packet and the MPLS EXP bits are copied into the label header.
5. The router forwards the labeled packets to the appropriate output interface for processing.
6. The router also forwards the 802.1p bits or the IP ToS bits to the output interface.
7. The outbound packet is differentiated by the MPLS EXP field for marking or policing.
8. The labeled packets (marked with EXP) are sent to another LSR in the core MPLS network or to an LER at the output edge.



### Note

Within the network, there is no IP precedence field for the queueing algorithm to use because the packets are MPLS packets. The packets remain MPLS packets until they arrive at PE2, the provider edge router.

## LERs at the Egress Edge of an MPLS Network

At the egress edge of an MPLS network, LERs process packets as follows:

1. MPLS-labeled packets (and 802.1p bits or IP ToS bits) from a core LSR arrive at the egress LER (PE2) from the MPLS network backbone.
2. The router pops the MPLS labels (disposition) from the packets. Aggregate and nonaggregate labels are classified with the EXP value by default.
3. For aggregate labels, the router performs a lookup on the IP address to determine the packet's destination; the router then forwards the packet to the appropriate output interface for processing. For nonaggregate labels, forwarding is based on the label. By default, nonaggregate labels are popped at the penultimate-hop router (next to last), not the egress PE router.
4. The router also forwards the 802.1p bits or the IP ToS bits to the output interface.
5. The packets are differentiated according to the 802.1p bits or the IP ToS bits and treated accordingly.

**Note**

The MPLS EXP bits allow you to specify the QoS for an MPLS packet. The IP precedence and DSCP bits allow you to specify the QoS for an IP packet.

## MPLS QoS Classification at the Edges and the Core

This section includes the following topics:

- [IP to MPLS, page 19-310](#)
- [MPLS to MPLS, page 19-311](#)
- [MPLS to IP, page 19-313](#)

### IP to MPLS

This section provides information about QoS features for LERs at the ingress (CE-to-PE) and egress (PE-to-CE) edges for MPLS and MPLS VPN networks. Both MPLS and MPLS VPN support general MPLS QoS features.

The router provides the following MPLS QoS capabilities at the IP-to-MPLS edge:

- Assigning an EXP value based on the **policy-map** command
- Marking an EXP value using a policy
- Policing traffic using a policy

This section includes the following topics:

- [Classification for IP to MPLS, page 19-310](#)
- [Classification for IP-to-MPLS Mode MPLS QoS, page 19-311](#)
- [Classification at IP-to-MPLS Ingress Port, page 19-311](#)
- [Classification at IP-to-MPLS Egress Port, page 19-311](#)

### Classification for IP to MPLS

The router ingress and egress policies for IP traffic classify traffic on the original received IP using **match** commands for IP precedence, IP DSCP, and IP ACLs.

After the router applies the QoS policies, it assigns the internal DSCP. The router then assigns the EXP value based on the internal DSCP-to-EXP global map for the labels that it imposes. If more than one label is imposed, the EXP value is the same in each label. The router preserves the original IP ToS when the MPLS labels are imposed.

The router assigns the egress CoS based on the internal DSCP-to-CoS global map. If the default internal DSCP-to-EXP and the internal DSCP-to-CoS maps are consistent, then the egress CoS has the same value as the imposed EXP.

If the ingress port receives both IP-to-IP and IP-to-MPLS traffic, you use classification to separate the two types of traffic. For example, if the IP-to-IP and IP-to-MPLS traffic have different destination address ranges, you can classify traffic on the destination address, apply IP ToS policies to the IP-to-IP traffic, and apply a policy (that marks or sets the EXP value in the imposed MPLS header) to the IP-to-MPLS traffic. See the following two examples:

- A router policy to mark IP ToS sets the internal DSCP—If it is applied to all traffic, then for IP-to-IP traffic, the egress port rewrites the CoS (derived from the internal DSCP) to the IP ToS byte in the egress packet. For IP-to-MPLS traffic, the router maps the internal DSCP to the imposed EXP value.
- A router policy to mark MPLS EXP sets the internal DSCP—If it is applied to all traffic, then for IP-to-IP traffic, the egress port rewrites the IP ToS according to the ingress IP policy (or trust). The CoS is mapped from the ToS. For IP-to-MPLS traffic, the router maps the internal DSCP to the imposed EXP value.

### Classification for IP-to-MPLS Mode MPLS QoS

MPLS QoS at the ingress to PE1 supports the following:

- Matching on IP precedence or DSCP values or filtering with an access group
- The **set mpls experimental imposition** and **police** commands

MPLS QoS at the egress of PE1 supports the **mpls experimental topmost** command.

### Classification at IP-to-MPLS Ingress Port

Classification for IP to MPLS is the same as for IP to IP. Port classification is based on the received Layer 2 802.1Q CoS value.

### Classification at IP-to-MPLS Egress Port

Port classification is based on the received EXP value, and the egress CoS value is mapped from that value.

If the egress port is a trunk, the ports copy the egress CoS into the egress 802.1Q field.

## MPLS to MPLS

This section provides information about MPLS QoS features for LSRs at the core (MPLS to MPLS) for MPLS and MPLS VPN networks.

MPLS QoS at the MPLS core supports the following:

- Per-EXP policing based on a service policy
- Copying the input topmost EXP value into the newly imposed EXP value
- Optional EXP mutation (changing of EXP values on an interface edge between two neighboring MPLS domains) on the egress boundary between MPLS domains



- Optional propagation of the topmost EXP value into the underlying EXP value when popping the topmost label from a multilabel stack.

This section includes the following topics:

- [Classification for MPLS to MPLS, page 19-312](#)
- [Classification for MPLS-to-MPLS QoS, page 19-313](#)
- [Classification at MPLS-to-MPLS Ingress Port, page 19-313](#)
- [Classification at MPLS-to-MPLS Egress Port, page 19-313](#)

## Classification for MPLS to MPLS

For received MPLS packets, the router trusts the EXP value in the topmost label.



### Note

The MPLS QoS ingress and egress policies for MPLS traffic classify traffic on the EXP value in the received topmost label when you enter the **match mpls experimental** command.

MPLS QoS maps the EXP value to the internal DSCP using the EXP-to-DSCP global map. What the router does next depends on whether it is swapping labels, imposing a new label, or popping a label:

- **Swapping labels**—When swapping labels, the router preserves the EXP value in the received topmost label and copies it to the EXP value in the outgoing topmost label. The router assigns the egress CoS using the internal DSCP-to-CoS global map. If the DSCP global maps are consistent, then the egress CoS is based on the EXP in the outgoing topmost label.

The router can mark down out-of-profile traffic using the **police** command's **exceed** and **violate** actions. It does not mark in-profile traffic, so the **conform** action must be transmitted and the **set** command cannot be used. If the router is performing a markdown, it uses the internal DSCP as an index into the internal DSCP markdown map. The router maps the result of the internal DSCP markdown to an EXP value using the internal DSCP-to-EXP global map. The router rewrites the new EXP value to the topmost outgoing label and does not copy the new EXP value to the other labels in the stack. The router assigns the egress CoS using the internal DSCP-to-CoS global map. If the DSCP maps are consistent, then the egress CoS is based on the EXP value in the topmost outgoing label.

- **Imposing an additional label**—When imposing a new label onto an existing label stack, the router maps the internal DSCP to the EXP value in the imposed label using the internal DSCP-to-EXP map. It then copies the EXP value in the imposed label to the underlying swapped label. The router assigns the egress CoS using the internal DSCP-to-CoS global map. If the DSCP maps are consistent, the egress CoS is based on the EXP value in the imposed label.

The router can mark in-profile and mark down out-of-profile traffic. After it marks the internal DSCP, the router uses the internal DSCP-to-EXP global map to map the internal DSCP to the EXP value in the newly imposed label. The router then copies the EXP in the imposed label to the underlying swapped label. The router assigns the egress CoS using the internal DSCP-to-CoS global map. Therefore, the egress CoS is based on the EXP in the imposed label.

- **Popping a label**—When popping a label from a multi-label stack, the router preserves the EXP value in the exposed label. The router assigns the egress CoS using the internal DSCP-to-CoS global map. If the DSCP maps are consistent, then the egress CoS is based on the EXP value in the popped label.
- If EXP propagation is configured for the egress interface, the router maps the internal DSCP to the EXP value in the exposed label using the DSCP-to-EXP global map. The router assigns the egress CoS using the internal DSCP-to-CoS global map. If the DSCP maps are consistent, the egress CoS is based on the EXP value in the exposed label.

## Classification for MPLS-to-MPLS QoS

MPLS QoS at the ingress to P1 or P2 supports the following:

- Matching with the **mpls experimental topmost** command
- The **set mpls experimental imposition, police, and police** with **set imposition** commands

MPLS QoS at the egress of P1 or P2 supports matching with the **mpls experimental topmost** command.

## Classification at MPLS-to-MPLS Ingress Port

Port classification is based on the ingress CoS from the router.

## Classification at MPLS-to-MPLS Egress Port

Port classification is based on the egress CoS value from the router.

If the egress port is a trunk, the LAN ports copy the egress CoS into the egress 802.1Q field.

## MPLS to IP

This section provides information about QoS features for LERs at the egress (PE-to-CE) edges for MPLS and MPLS VPN networks. Both MPLS and MPLS VPN support general MPLS QoS features.

MPLS QoS supports these capabilities at the MPLS-to-IP edge:

- Option to propagate the EXP value into IP DSCP on exit from an MPLS domain per egress interface
- Option to use IP service policy on the MPLS-to-IP egress interface

This section includes the following topics:

- [Classification for MPLS to IP, page 19-313](#)
- [Classification for MPLS-to-IP MPLS QoS, page 19-314](#)
- [Classification at MPLS-to-IP Ingress Port, page 19-314](#)
- [Classification at MPLS-to-IP Egress Port, page 19-314](#)

## Classification for MPLS to IP

The router assigns the internal DSCP (internal priority that the router assigns to each frame) based on the QoS result. The QoS result is affected by the following:

- Default trust EXP value
- Number of VPNs
- Explicit NULL use
- QoS policy

The router does one of the following:

- Preserves the underlying IP ToS
- Rewrites the IP ToS by a value derived from the EXP-to-DSCP global map
- Changes the IP ToS to any value derived from the egress IP policy

In all cases, egress queueing is based on the final IP ToS from the DSCP-to-CoS map.

For incoming MPLS packets on the PE-to-CE ingress, the router supports MPLS classification and ingress IP policies. The PE-to-CE traffic from the MPLS core is classified or policed on egress as IP.

## Classification for MPLS-to-IP MPLS QoS

MPLS QoS at the ingress to PE2 supports matching on the EXP value and the **police** command.

MPLS QoS at the egress of PE2 supports matching on the IP precedence, DSCP values, or filtering with an access group and the **police** command.

## Classification at MPLS-to-IP Ingress Port

Ingress port classification is based on the EXP value.

## Classification at MPLS-to-IP Egress Port

Classification for MPLS to IP is the same as it is for IP to IP.

Egress port classification is based on the egress CoS.

If the egress port is a trunk, the ports copy the egress CoS into the egress 802.1Q field.



### Note

For MPLS to IP, egress IP ACL or QoS is not effective on the egress interface if the egress interface has MPLS IP (or tag IP) enabled. The exception is a VPN CAM hit, where the packet is classified on egress as IP.

## MPLS DiffServ Tunneling Modes

Tunneling provides QoS the ability to be transparent from one edge of a network to the other edge of the network. A tunnel starts where there is label imposition. A tunnel ends where there is label disposition; that is, where the label is removed from the stack, and the packet goes out as an MPLS packet with a different per-hop behavior (PHB) layer underneath or as an IP packet with the IP PHB layer.

For the MPLS router, there are two ways to forward packets through a network:

- Short Pipe or Pipe mode—EXP marking implemented in the core does not propagate to the packet ToS byte. In Short Pipe mode, the egress PE router uses the original Layer 3 packet marking instead of the marking used by the intermediate provider (P) routers. In Pipe mode, the egress PE router uses the Layer 2 marking of the intermediate provider (P) routers.
- Uniform mode—EXP marking implemented in the core is propagated to the underlying ToS byte. In Uniform mode, you can manipulate the marking in the IP packet to reflect the operator's QoS marking in the core. This mode provides consistent QoS classification and marking throughout the network including the CE and core routers.

Both tunneling modes affect the behavior of edge and penultimate LSRs where labels are put onto packets and removed from packets. They do not affect label swapping at intermediate routers. An operator can choose different types of tunneling modes for each customer.

For additional information, see *MPLS DiffServ Tunneling Modes* at this URL:

[http://www.cisco.com/en/US/docs/ios/12\\_2t/12\\_2t13/feature/guide/ftdtmode.html](http://www.cisco.com/en/US/docs/ios/12_2t/12_2t13/feature/guide/ftdtmode.html)

## MPLS QoS and HA

The Cisco NX-OS architecture and High Availability (HA) infrastructure provide support for feature components to be restarted and resume operations transparently to other services on the device and on neighboring devices. This feature allows for continuous operation and zero data loss during planned software changes and unplanned software failures.

MPLS QoS supports these Cisco NX-OS HA features:

- Nonstop forwarding (NSF)
- Stateful HA

MPLS QoS supports these Cisco NX-OS HA technologies to allow NSF and stateful HA:

- Stateful process restart
- Stateful switch over (SSO)
- In-Service Software Upgrade (ISSU)

## Licensing Requirements for MPLS QoS

Product	License Requirement
Cisco NX-OS	MPLS QoS requires an MPLS license. For a complete explanation of the Cisco NX-OS licensing scheme and how to obtain and apply licenses, see the <i>Cisco NX-OS Licensing Guide</i> .

## Prerequisites for MPLS QoS

MPLS QoS has the following prerequisites:

- Your network must support Multiprotocol Label Switching (MPLS)
- Your network must support at least one of the following Interior Gateway (IGP) protocols:
  - Intermediate System-to-Intermediate System (IS-IS)
  - Open Shortest Path First (OSPF)

## Guidelines and Limitations for MPLS QoS

MPLS QoS has the following configuration guidelines and limitations:

- There is no global command to enable or disable MPLS QoS. If no QoS polices are configured, the switch follows the default behavior described in this section.
- For IP-to-MPLS imposition when the received packet is an IP packet, the following applies:
  - When no QoS polices are configured, the EXP value is based on the received IP ToS.
- For MPLS-to-MPLS operations, the following applies:
  - When swapping and no QoS polices are configured, the EXP value is based on the original EXP value (in the absence of EXP mutation).

- When swapping and QoS is queuing only, the EXP value is based on the original EXP value (in the absence of EXP mutation).
- When imposing an additional label and no QoS policies are configured, the EXP value is based on the original EXP value (in the absence of EXP mutation).
- When imposing an additional label and QoS is queuing only, the EXP value is based on the original EXP value (in the absence of EXP mutation).
- When popping one label and no QoS policies are configured, the EXP value is based on the underlying EXP value.
- When popping one label and QoS is queuing only, the EXP value is based on the underlying EXP value.
- For classifying MPLS packets with class maps, the following applies:
  - The **match mpls experimental** command specifies the name of an EXP field value to be used as the match criterion against which packets are checked to determine if they belong to the class specified by the class map.
  - To use the **match mpls experimental** command, you must first enter the **class-map** command to specify the name of the class whose match criteria you want to establish. After you identify the class, you can use the **match mpls experimental** command to configure its match criteria.
  - If you specify more than one command in a class map, only the last command entered applies. The last command overrides the previously entered commands.
- When configuring a policy map, the following applies:
  - You can attach only one policy map of a given type to an interface in a specific direction.
- When setting the EXP value on all imposed labels, the following applies:
  - Use the **set mpls experimental imposition** command during label imposition. This command sets the MPLS EXP field on all imposed label entries.
  - The **set mpls experimental imposition** command is supported only on input interfaces (imposition).
  - The **set mpls experimental imposition** command does not mark the EXP value directly; instead, it marks the internal DSCP that is mapped to EXP through the internal DSCP-to-EXP global map.
  - It is important to note that classification (based on the original received IP header) and marking (done to the internal DSCP) do not distinguish between IP-to-IP traffic and IP-to-MPLS traffic. The commands that you use to mark IP ToS and mark EXP have the same result as when you mark the internal DSCP.
  - Use the **set mpls experimental imposition** command to set the pushed label entry value to a value that is different from the default value during label imposition.
  - You optionally can use the **set mpls experimental imposition** command with the IP precedence, DSCP field, or QoS IP ACL to set the value of the MPLS EXP field on all imposed label entries.
  - When imposing labels onto the received IP traffic, you can mark the EXP field using the **set mpls experimental imposition** command.
- When using the **police** command to configure a policy map, the following applies:
  - With MPLS, the **exceed-action action** command and the **violate-action action** command work similarly to IP usage. The packet might get dropped or the EXP value is marked down.

- When swapping labels for received MPLS traffic, you can mark down out-of-profile traffic using the **police** command **exceed-action policed-dscp-transmit** and **violate-action policed-dscp-transmit** keywords. The router does not mark in-profile traffic; when marking down out-of-profile traffic, the router marks the outgoing topmost label. The router does not propagate the marking down through the label stack.
- You can use the **police** command to set the pushed label entry value to a value that is different from the default value during label imposition.
- When imposing labels onto the received IP traffic, you can mark the EXP field using the **conform-action set-mpls-exp-imposition-transmit** keywords.
- Before you downgrade from Cisco NX-OS Release 5.2 or later to an earlier Cisco NX-OS release, clear the QoS MIB and MPLS QoS defaults using the **clear qos mpls-snmp** command. Otherwise, the downgrade might fail.
- When you configure a partial queueing policy such as the **set mpls-exp-topmost cos table exp-cos-map** command on a default queue, only the MPLS configuration is programmed in the hardware. Other parameters in the hardware, such as queue limits, bandwidth, and thresholds, retain the previously applied configuration. When the line card is reloaded, previously applied configuration parameters are not retained because new policy parameters are absent for the queue limits, bandwidth, and thresholds. As a result, some hardware parameters might be different before and after the reload. To address this problem, define parameters like queue limits, bandwidth, and thresholds for class maps along with the MPLS configuration to copy the EXP bits to cos.

## Default Settings for MPLS QoS

Table 19-1 lists the default settings for MPLS QoS parameters.

**Table 19-1** Default Settings for MPLS QoS

Parameters	Default
Port CoS value	0 (zero)
Port-based or VLAN-based QoS	Port-based
EXP to DSCP map (DSCP set from EXP values)	EXP 0 = DSCP 0 EXP 1 = DSCP 8 EXP 2 = DSCP 16 EXP 3 = DSCP 24 EXP 4 = DSCP 32 EXP 5 = DSCP 40 EXP 6 = DSCP 48 EXP 7 = DSCP 56
IP precedence to DSCP map (DSCP set from IP precedence values)	IP precedence 0 = DSCP 0 IP precedence 1 = DSCP 8 IP precedence 2 = DSCP 16 IP precedence 3 = DSCP 24 IP precedence 4 = DSCP 32 IP precedence 5 = DSCP 40 IP precedence 6 = DSCP 48 IP precedence 7 = DSCP 56

**Table 19-1**     *Default Settings for MPLS QoS (continued)*

Parameters	Default
DSCP to EXP map (EXP set from DSCP values)	DSCP 0–7 = EXP 0 DSCP 8–15 = EXP 1 DSCP 16–23 = EXP 2 DSCP 24–31 = EXP 3 DSCP 32–39 = EXP 4 DSCP 40–47 = EXP 5 DSCP 48–55 = EXP 6 DSCP 56–63 = EXP 7
Marked-down DSCP from DSCP map	Marked-down DSCP value equals original DSCP value (no mark down)
EXP mutation map	No mutation map by default
Policers	None
Policy maps	None
MPLS flow mask in NetFlow table	Label and EXP value
MPLS core QoS	<p>There are four possibilities at the MPLS core QoS:</p> <ul style="list-style-type: none"> <li>Swapping—The incoming EXP field is copied to the outgoing EXP field.</li> <li>Swapping and imposition—The incoming EXP field is copied to both the swapped EXP field and the imposed EXP field.</li> </ul> <p><b>Note</b> If there is a service policy with a set for EXP field, its EXP field is placed into the imposed label and also into the swapped label.</p> <ul style="list-style-type: none"> <li>Disposition of topmost label—The exposed EXP field is preserved.</li> <li>Disposition of only label—The exposed IP DSCP is preserved.</li> </ul>
MPLS to IP edge QoS	Preserve the exposed IP DSCP

## Configuring MPLS QoS



### Note

You can configure MPLS QoS commands inside a config session.

This section include the following topics:

- [Configuring a Class Map to Classify MPLS Packets, page 19-319](#)
- [Configuring a Policy Map, page 19-319](#)
- [Creating a Table Map, page 19-322](#)

# Configuring a Class Map to Classify MPLS Packets

You can configure a class map.

## SUMMARY STEPS

1. **configure terminal**
2. **[no] class-map [type qos] [match-any] class-map-name**
3. **[no] match [not] mpls experimental topmost exp-list**

## DETAILED STEPS

	Command	Purpose
Step 1	<b>configure terminal</b>  <b>Example:</b> switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	<b>[no] class-map [type qos] [match-any] class-map-name</b>  <b>Example:</b> switch(config)# class-map type qos match-any Class2 switch(config-cmap-qos)#	Defines a class map, enters class-map configuration mode, and specifies the packet matching criteria as follows: <ul style="list-style-type: none"> <li>• <b>match-any</b>—(Optional) Specifies that if a packet matches any of the policies of this class map, the class map is applied to the packet.</li> </ul>
Step 3	<b>[no] match [not] mpls experimental topmost exp-list</b>  <b>Example:</b> switch(config-cmap-qos)# match mpls experimental topmost 2, 5-7	Specifies that the packets should be matched (or not) on the 3-bit experimental (EXP) field in the outermost (topmost) MPLS label in the MPLS header as follows: <ul style="list-style-type: none"> <li>• <b>exp-list</b>—The list can contain values and ranges. Values can range from 0 to 7.</li> </ul>

# Configuring a Policy Map

This section includes the following topics:

- [Configuring a Policy Map to Set the EXP Value on All Imposed Labels, page 19-319](#)
- [Configuring a Policy Map Using the Police Command, page 19-320](#)
- [Configuring a Policy Map Using Table Maps, page 19-321](#)

## Configuring a Policy Map to Set the EXP Value on All Imposed Labels

You can configure a policy map to set the EXP value on all imposed labels.

To set the value of the MPLS EXP field on all imposed label entries, use the **set mpls experimental imposition** command in QoS policy-map class configuration mode. To disable the setting, use the **no** form of this command.

## SUMMARY STEPS

1. **configure terminal**



2. **[no] policy-map [type qos] policy-map-name**
3. **[no] class [type qos] {class-map-name | class-default} [insert-before class-map-name]**
4. **set mpls experimental imposition mpls-exp-value**

## DETAILED STEPS

	Command	Purpose
Step 1	<b>configure terminal</b>  <b>Example:</b> switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	<b>[no] policy-map [type qos] policy-map-name</b>  <b>Example:</b> switch(config)# policy-map Policy1 switch(config-pmap-qos)#	Defines a class map and enters class-map configuration mode.
Step 3	<b>[no] class [type qos] {class-map-name   class-default} [insert-before class-map-name]</b>  <b>Example:</b> switch(config-pmap-qos)# class Class2 switch(config-pmap-c-qos)	Specifies the class name of the policy to create or change: <ul style="list-style-type: none"> <li><b>class-map-name</b>—The name of the class to configure or modify the policy.</li> <li><b>class-default</b>—A predefined class to which traffic is directed if that traffic does not match any of the match criteria in the configured class maps.</li> </ul>
Step 4	<b>set mpls experimental imposition mpls-exp-value</b>  <b>Example:</b> switch(config-pmap-c-qos)# set mpls experimental imposition 3	Sets the value of the MPLS experimental (EXP) field on all imposed label entries.

## Configuring a Policy Map Using the Police Command

Policing is a function in the router hardware that provides the ability to rate limit a particular traffic class to a specific rate. The router supports aggregate policing. Microflow policing is not supported.

Aggregate policing meters all traffic that ingresses into a port, regardless of the different source, destination, protocol, source port, or destination port.



### Note

For additional information about using the **police** command, see the *Cisco Nexus 7000 Series NX-OS Quality of Service Configuration Guide, Release 6.x*.

## SUMMARY STEPS

1. **configure terminal**
2. **[no] policy-map [type qos] policy-map-name**
3. **[no] class [type qos] {class-map-name | class-default}**
4. **[no] police [cir] {x [bps | kbps | mbps | gbps] | percent x-percent} [[bc] bc [bytes | kbytes | mbytes | ms | us]] [pir y [bps | kbps | mbps | gbps] | percent y-percent] [[be] be [bytes | kbytes | mbytes | ms | us]] [conform conform-action [exceed exceed-action [violate violate-action]]]**

## DETAILED STEPS

	Command	Purpose
Step 1	<b>configure terminal</b>  <b>Example:</b> switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	<b>[no] policy-map [type qos] policy-map-name</b>  <b>Example:</b> switch(config)# policy-map Policy1 switch(config-pmap-qos)	Defines a class map and enters class-map configuration mode.
Step 3	<b>[no] class [type qos] {class-map-name   class-default}</b>  <b>Example:</b> switch(config-pmap-qos)# class Class2 switch(config-pmap-c-qos)	Specifies the class name of the policy to create or change: <ul style="list-style-type: none"> <li><b>class-map-name</b>—The name of the class to configure or modify the policy.</li> <li><b>class-default</b>—A predefined class to which traffic is directed if that traffic does not match any of the match criteria in the configured class maps.</li> </ul>
Step 4	<b>[no] police [cir] {x [bps   kbps   mbps   gbps]   percent x-percent} [[bc] bc [bytes   kbytes   mbytes   ms   us]] [pir y [bps   kbps   mbps   gbps]   percent y-percent] [[be] be [bytes   kbytes   mbytes   ms   us]] [conform conform-action [exceed exceed-action [violate violate-action]]]</b>  <b>Example:</b> switch(config-pmap-c-qos)# police cir 256000 conform set-mpls-exp-topmost-transmit violate drop	Specifies that a class of traffic should have a maximum rate imposed on it, and if that rate is exceeded, an immediate action must be taken.  In addition to the conform actions described in the <i>Cisco Nexus 7000 Series NX-OS Quality of Service Configuration Guide, Release 6.x</i> , MPLS QoS provides two conform actions: <ul style="list-style-type: none"> <li><b>set-mpls-exp-imposition-transmit</b>—Sets the EXP field on all imposed labels to a specified value and transmits the packet.</li> <li><b>set-mpls-exp-topmost-transmit</b>—Sets the EXP field on the outer (topmost) label to a specified value and transmits the packet.</li> </ul>

## Configuring a Policy Map Using Table Maps

You can use the system-defined table maps to perform marking in the **set** and **police** policy map class commands.

**Note**

For general information about using table maps, see the *Cisco Nexus 7000 Series NX-OS Quality of Service Configuration Guide, Release 6.x*.

## SUMMARY STEPS

1. **configure terminal**
2. **[no] policy-map [type qos] policy-map-name**
3. **[no] class [type qos] {class-map-name | class-default}**
4. **[no] set to-field from-field table table-map-name**

## DETAILED STEPS

	Command	Purpose
Step 1	<code>configure terminal</code>  <b>Example:</b> switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	<code>[no] policy-map [type qos] policy-map-name</code>  <b>Example:</b> switch(config)# policy-map Policy1 switch(config-pmap-qos)	Defines a class map and enters class-map configuration mode.
Step 3	<code>[no] class [type qos] {class-map-name   class-default}</code>  <b>Example:</b> switch(config-pmap-qos)# class Class2 switch(config-pmap-c-qos)	Specifies the class name of the policy to create or change: <ul style="list-style-type: none"> <li><i>class-map-name</i>—The name of the class to configure or modify the policy.</li> <li><b>class-default</b>—A predefined class to which traffic is directed if that traffic does not match any of the match criteria in the configured class maps.</li> </ul>
Step 4	<code>set to-field from-field table table-map-name</code>  <b>Example:</b> switch(config-pmap-c-qos)# set cos mpls-exp-topmost table dscp-cos-map	Defines a mapping of values between two QoS fields.  In addition to the <i>to-field</i> and <i>from-field</i> arguments described in the <i>Cisco Nexus 7000 Series NX-OS Quality of Service Configuration Guide, Release 6.x</i> , MPLS QoS provides the following fields: <ul style="list-style-type: none"> <li><i>to-field</i>: <ul style="list-style-type: none"> <li><b>mpls-exp-topmost</b>—The EXP field on the outer (topmost) label.</li> </ul> </li> <li><i>from-field</i>: <ul style="list-style-type: none"> <li><b>mpls-exp-imposition</b>—The EXP field to be applied on all imposed labels.</li> <li><b>mpls-exp-topmost</b>—The EXP field to be applied on the outer (topmost) label.</li> </ul> </li> </ul> <p><b>Note</b> The <i>table-map-name</i> argument can be the name of a system-defined table map or an existing table map defined using the <b>table-map</b> command.</p>

## Creating a Table Map

You can define a table that remaps QoS values for use in the **set** and **police** policy map class commands.

**Note**

For additional information about table maps, see the *Cisco Nexus 7000 Series NX-OS Quality of Service Configuration Guide, Release 6.x*.

## SUMMARY STEPS

1. `configure terminal`

2. **table-map** *table-map-name*
3. **from** *number* **to** *number*
4. Repeat step 3 to complete table.

## DETAILED STEPS

	Command	Purpose
Step 1	<b>configure terminal</b>  <b>Example:</b> switch# configure terminal switch(config)#	Enters global configuration mode.
Step 2	<b>table-map</b> <i>table-map-name</i>  <b>Example:</b> switch(config)# table-map TableMap1 switch(config-tmap)	Creates a table map and enters table map configuration mode.
Step 3	<b>from</b> <i>number</i> <b>to</b> <i>number</i>  <b>Example:</b> switch(config-tmap)# from 1 to 1 switch(config-tmap)# from 2 to 1 switch(config-tmap)# from 3 to 2 switch(config-tmap)# from 4 to 2 ...	Maps one number to another. The range of <i>number</i> is from 0 to 63. This step can repeat up to 64 times.
Step 4	Repeat Step 3 to complete table.	—

## Verifying the MPLS QoS Configuration

To display the MPLS QoS configuration, perform the following task:

Command	Purpose
show policy-map type qos interface <i>interface</i>	Displays the statistics that show the packets matched for every class on that interface in the given direction.

*Need supported show commands, with examples.*

## Configuration Examples for MPLS QoS

This section includes the following configuration examples:

- [Example: Configuring a Class Map to Classify MPLS Packets, page 19-324](#)
- [Example: Configuring a Policy Map to Set the EXP Value on All Imposed Labels, page 19-324](#)
- [Example: Configuring a Policy Map Using the Police Command, page 19-324](#)
- [Example: Configuring a Policy Map Using Table Maps, page 19-324](#)

## Example: Configuring a Class Map to Classify MPLS Packets

The following example shows how to create a class map to match EXP field values 2 and 5 through 7 on the outer (topmost) label of an MPLS header:

```
switch# configure terminal
switch(config)# class-map Class2
switch(config-cmap-qos)# match mpls experimental topmost 2, 5-7
```

## Example: Configuring a Policy Map to Set the EXP Value on All Imposed Labels

The following example shows how to create a policy map to set the EXP field to a value of 3 on all imposed labels of an MPLS header:

```
switch# configure terminal
switch(config)# policy-map Policy1
switch(config-pmap-qos)# class Class2
switch(config-pmap-c-qos)# set mpls experimental imposition 3
```

## Example: Configuring a Policy Map Using the Police Command

The following example shows how to create a policy map to enforce a committed data rate of 256000 bps. If the data rate is in conformance, the router sets the EXP field of the outer (topmost) label of the MPLS header. If the data rate is exceeded, the router drops packets.

```
switch# configure terminal
switch(config)# policy-map Policy1
switch(config-pmap-qos)# class Class2
switch(config-pmap-c-qos)# police cir 256000 conform set-mpls-exp-topmost-transmit violate drop
```

## Example: Configuring a Policy Map Using Table Maps

The following example shows how to create a policy map that maps CoS values of 0 to 3 to an EXP field value of 1 and CoS values of 4 to 7 to an EXP field value of 6. The EXP value is then written to the outer (topmost) label of the MPLS header.

```
switch# configure terminal
switch(config)# table-map TableMap1
switch(config-tmap)# from 0 to 1
switch(config-tmap)# from 1 to 1
switch(config-tmap)# from 2 to 1
switch(config-tmap)# from 3 to 1
switch(config-tmap)# from 4 to 6
switch(config-tmap)# from 5 to 6
switch(config-tmap)# from 6 to 6
switch(config-tmap)# from 7 to 6
switch(config-tmap)# exit
switch(config)# policy-map Policy1
switch(config-pmap-qos)# class Class2
switch(config-pmap-c-qos)# set cos mpls-exp-topmost table TableMap1
```

# Additional References for MPLS QoS

The following sections provide references related to the MPLS QoS feature.

## Related Document

Related Topic	Document Title
Cisco NX-OS QoS configuration	<i>Cisco Nexus 7000 Series NX-OS Quality of Service Configuration Guide, Release 6.x</i>
Cisco NX-OS MPLS QoS commands	<i>Cisco Nexus 7000 Series NX-OS Quality of Service Command Reference</i>
Cisco NX-OS MPLS commands	<i>Cisco NX-OS Multiprotocol Label Switching Command Reference</i>

## MIBs

MIB	MIBs Link
No new or modified MIBs are supported by this feature, and support for existing MIBs has not been modified by this feature.	To locate and download MIBs for selected platforms, Cisco IOS releases, and feature sets, use Cisco MIB Locator found at the following URL: <a href="http://www.cisco.com/go/mibs">http://www.cisco.com/go/mibs</a>

## Feature History for MPLS QoS

[Table 19-2](#) lists the release history for this feature.

**Table 19-2**      *Feature History for MPLS QoS*

Feature Name	Releases	Feature Information
MPLS QoS	5.2(1)	This feature was introduced.