

MPLS DiffServ Tunneling Modes

MPLS DiffServ Tunneling Modes allows service providers to manage the quality of service (QoS) that a router will provide to a Multiprotocol Label Switching (MPLS) packet in an MPLS network. MPLS DiffServ Tunneling Modes conforms to the IETF draft standard for Uniform, Short Pipe, and Pipe modes. It also conforms to Cisco-defined extensions for scalable command line interface (CLI) management of those modes at customer edge, provider edge, and core routers.

The following features are supported on MPLS DiffServ Tunneling Modes:

- MPLS per-hop behavior (PHB) layer management.
- There is improved scalability of the MPLS layer management by control on managed customer edge (CE) routers.
- MPLS can “tunnel” a packet’s QoS (that is, the QoS is transparent from edge to edge).
- The MPLS experimental (MPLS EXP) field can be marked differently and independently of the PHB marked in the IP Precedence or differentiated services code point (DSCP) field.
- There are three MPLS QoS tunneling modes for the operation and interaction between the DiffServ marking in the IP header and the DiffServ marking in the MPLS header: Pipe mode with an explicit NULL LSP, Short Pipe mode, and Uniform mode. Pipe mode with an explicit NULL LSP and Short Pipe mode allow an MPLS network to transparently tunnel the DiffServ marking of packets.

MPLS DiffServ Tunneling Modes has the following benefits:

- Tunneling modes provide added QoS functionality by the creative manipulation of the MPLS EXP field during label imposition, forwarding, and label disposition.
- Tunneling modes provide a common set of PHBs to different service provider customers.
- Pipe mode provides transparency and customized edge service.
- Pipe mode with an explicit NULL LSP improves the scalability of management by performing per-customer packet metering and marking closer to the service provider’s customer networks.
- Pipe mode with an explicit NULL LSP provides QoS transparency by ensuring that customer’s packets will not be re-marked in the service provider’s network.
- In Pipe mode with an explicit NULL LSP, the explicit NULL LSP applies the service provider’s PHBs on the ingress CE-to-PE link.
- In Pipe mode with an explicit NULL LSP, the service provider’s PHBs are applied on the egress PE-to-CE link.

- Short Pipe mode provides transparency, standard edge service, and scalability.
- Short Pipe mode provides PHB management on the PE router. The customer's set of PHBs is applied on both the egress PE-to-CE link and on the ingress CE-to-PE link.
- Customers are likely to use Uniform mode if they have no markings or few markings. The customer lets the Internet service provider (ISP) mark the packets and retain their markings.
- In Uniform mode, all changes to QoS markings are reflected at each level (that is, IGP, BGP, and IP).
- In Uniform mode, if a QoS marking is changed in the MPLS network, it is changed in the IP packet too.

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Prerequisites for MPLS DiffServ Tunneling Modes

- Set up the network to run MPLS.
- Enable IP Cisco Express Forwarding (CEF).
- Define the Service Level Agreement (SLA).
- Know each customer's per-hop behavior.
  - What do customers expect you to provide?
  - Are customers going to mark the traffic?
- Identify whether the customer's traffic will be voice or data.
- Determine the topology and interfaces that need to be configured.
- Understand how IP and MPLS packets are forwarded.

Restrictions for MPLS DiffServ Tunneling Modes

- A single label-switched path (LSP) can support up to eight classes of traffic (that is, eight PHBs) because the MPLS EXP field is a 3-bit field.
- MPLS DiffServ Tunneling Modes does not support L-LSPs. Only E-LSPs are supported.

Information About MPLS DiffServ Tunneling Modes

QoS and Its Use in MPLS Tunneling

This section includes the following subsections:

What is QoS

Critical applications must be guaranteed the network resources they need, despite a varying network traffic load. QoS is a set of techniques that manage the following:

- Network bandwidth--Noncritical traffic is prevented from using bandwidth that critical applications need. The main cause of congestion is lack of bandwidth.
- Network delay (also called latency)--The time required to move a packet from the source to the destination over a path.
- Jitter--The interpacket delay variance; that is, the difference between interpacket arrival and departure. Jitter can cause data loss.
- Packet loss--The dropping of packets.

Service providers offering MPLS VPN and traffic engineering (TE) services can provide varying levels of QoS for different types of network traffic. For example, Voice-over-IP (VoIP) traffic receives service with an assured minimum of delay, whereas e-commerce traffic might receive a minimum bandwidth guarantee (but not a delay guarantee).

For more information about QoS, see the *Cisco IOS Quality of Service Solutions Configuration Guide* , Release 12.2 and the *Cisco IOS Quality of Service Solutions Command Reference* , Release 12.2.

Services Supported by MPLS QoS

MPLS QoS supports the following services:

- Class-based weighted fair queuing (CBWFQ)--Provides queuing based on defined classes, with no strict priority queue available for real-time traffic. Weighted fair queuing allows you to define traffic classes based on match criteria. Once a class has been defined, you can assign characteristics to the class. For example, you can designate the minimum bandwidth delivered to the class during congestion.
- Low latency queuing (LLQ)--Provides strict priority queuing, which allows delay-sensitive data such as voice to be processed and sent first, before packets in other queues are processed. This provides preferential treatment to delay-sensitive data over other traffic.
- Weighed fair queuing (WFQ)--An automated scheduling system that uses a queuing algorithm to ensure fair bandwidth allocation to all network traffic. Weighted fair queuing is based on a relative bandwidth applied to each of the queues.
- Weighted random early detection (WRED)--RED is a congestion avoidance mechanism that controls the average queue size by indicating to the end hosts when they should temporarily stop sending packets. A small percentage of packets is dropped when congestion is detected and before the queue in question overflows completely.

The weighted aspect of WRED ensures that high-precedence traffic has lower loss rates than other traffic during congestion. WRED can be configured to discard packets that have certain markings. When a packet comes into a router, it is assigned an internal variable that is called a discard class. If desired, you can set the discard class at the input interface. At the output interface, the router can be configured to use the discard class for WRED instead of the MPLS EXP field.

Service Level Agreements Used in MPLS Tunneling

The service provider has an SLA with each customer. Each customer can have a different SLA. For example, the SLA for customer C1 may allow 256 kilobits of bandwidth for TCP packets (such as FTP packets or Telnet packets) and 1 megabyte of voice traffic per second. If the customer transmits 1 megabyte of voice traffic per second, the service provider delivers it to the other side of the customer's network. If the customer transmits more, the excess traffic is considered out-of-rate traffic and may or may not be discarded.

If the service provider experiences congestion, the service provider decides how to handle those packets. For example, the service provider may drop packets or give them less bandwidth. The PHB may be to drop a packet or to give it 20 percent of the link bandwidth.

The PHB that the service provider provides for a packet may be different from the PHB that the customer wants traffic to have in their network. The customer may be providing QoS at the output interface of each router in their network. However, the customer may be providing a different amount of bandwidth on those links than the service provider will provide. For example, a customer may give 50 percent of the link bandwidth to voice. The service provider may want to give only 10 percent of the link bandwidth to voice.

Providing QoS to an IP Packet

In an IP packet, the QoS that a router must provide has traditionally been designated in the IP Precedence field, which is the first three bits of the type of service (ToS) byte in the header of an IP packet. The IP Precedence and the differentiated services code point (DSCP) in an IP packet define the class. They may also designate the discard profile within a class. The DSCP is specified in the IETF standard for DiffServ. It is a new IETF standard for QoS.

Although some people still use the IP Precedence field, others use the DSCP to indicate the PHB that will be provided to an IP packet.

After label imposition, a configurable mapping function marks an equivalent PHB into the 3-bit MPLS EXP field value based on the IP Precedence or the IP DSCP marking.

Providing QoS to an MPLS Packet

In an MPLS packet, the PHB is marked in the MPLS EXP field within the MPLS label entry.

The EXP bits are similar in function to the IP Precedence and the DSCP in the IP network. The EXP bits generally carry all the information encoded in the IP Precedence or the DSCP.

The edge LSR that imposes the MPLS header sets the MPLS EXP field to a value.

DiffServ as a Standardization of QoS

DiffServ is a QoS architecture for IP networks. Packets within a DiffServ-enabled network may be classified into classes such as premium, gold, silver, or bronze based on QoS requirements. For example, VoIP packets may be grouped into the premium class, and e-commerce HTTP packets may be grouped into the gold class.

Each class has a marking associated with it. This makes packet classification extremely scalable and assures appropriate bandwidth and delay guarantees in the network. When packets enter the network, they are marked based on classification policies at the network boundary routers. The boundary routers also apply traffic

conditioning functions to control the amount of traffic entering the network. Traffic conditioning includes the following:

- Shaping--Smoothing the rate at which packets are sent into the network
- Policing--Dropping packets that exceed a subscribed-to-rate, or re-marking packets exceeding the rate so that the probability of dropping them increases when there is congestion

Each router within the network then applies different queuing and dropping policies on each packet based on the marking that the packet carries.

For more information about DiffServ, see the *Cisco IOS Switching Services Configuration Guide* , Release 2.2.

Tunneling Modes for MPLS DiffServ

Tunneling is the ability of QoS 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 popped off of the stack and the packet goes out as an MPLS packet with a different PHB layer underneath or as an IP packet with the IP PHB layer.

There are three ways to forward packets through a network:

- Pipe mode with an explicit NULL LSP
- Short Pipe mode
- Uniform mode

Pipe mode and Short Pipe mode provide QoS transparency. With QoS transparency, the customer's IP marking in the IP packet is preserved.



Note The only difference between Pipe mode and Short Pipe mode is which PHB is used on the service provider's egress edge router. In Pipe mode with an explicit NULL LSP, QoS is done on the PE-to-CE link based on the service provider's PHB markings. The egress LSR still uses the marking that was used by intermediate LSRs.

All three tunneling modes affect the behavior of edge and penultimate label switching routers (LSRs) where labels are pushed (put onto packets) and popped (removed from packets). They do not affect label swapping at intermediate routers. A service provider can choose different types of tunneling modes for each customer.

Following is a brief description of each tunneling mode:

- Pipe mode with an explicit NULL LSP--QoS is done on the output interface of the PE router based on the received MPLS EXP field, even though one or more label entries have been popped. The IP Precedence field, EXP bits, and the DSCP field are not altered when they travel from the ingress to the egress of the MPLS network.

Any changes to the packet marking within the MPLS network are not permanent and do not get propagated when the packet leaves the MPLS network. The egress LSR still uses the marking that was used by intermediate provider core (P) routers. However, the egress provider edge (PE) router has to remove labels imposed on the original packet. To preserve the marking carried in the labels, the edge PE router keeps an internal copy of the marking before removing the labels. This internal copy is used to classify the packet on the outbound interface (facing the CE) after the labels are removed.

For a detailed description, see the Pipe Mode with an Explicit NULL LSP, on page 7.

For the configuration procedure, see the Configuring Pipe Mode with an Explicit NULL LSP, on page 15.

For an example, see the Pipe Mode with an Explicit NULL LSP Configuration Example, on page 39.

- Short Pipe mode--In Short Pipe mode, the egress PE router uses the original packet marking instead of the marking used by the intermediate P routers.

For a detailed description, see the Short Pipe Mode, on page 10.

For the configuration procedure, see the Configuring Short Pipe Mode, on page 24.

For an example, see the Short Pipe Mode Configuration Example, on page 40.

- Uniform mode--In Uniform mode, the marking in the IP packet may be manipulated to reflect the service provider's QoS marking in the core.

For a detailed description, see the Uniform Mode, on page 13.

For the configuration procedure, see the Configuring Uniform Mode, on page 30.

For an example, see the Uniform Mode Configuration Example, on page 42.

MPLS PHB Layer Management

Through the network of routers, the MPLS EXP field can be marked differently and independently of the PHB marked in the IP Precedence or the DSCP field. A service provider can choose from existing classification criteria, including or excluding the IP PHB marking, to classify packets into a different PHB which is then marked only in the MPLS EXP field during label imposition.

Layer management is the ability to apply an additional layer of PHB marking to a packet. The PHB is the behavior of a packet at a router (that is, the unique discard and scheduling behavior that is applied to a packet). Layer management can occur at a service provider-managed CE router or at the service provider edge (PE) router.

If a packet arrives in a network as an IP packet, it may already have a PHB layer that is represented by a marking in the ToS byte. The marking can be IP Precedence bits or the DSCP.

If a packet arrives as an MPLS packet, it already has the following two PHB layers:

- IP layer
- MPLS layer, where the marking is in the MPLS EXP field of the topmost label entry

At a given hop, one PHB layer can be added to a packet. If only one label is being pushed onto the packet, the marking for the PHB layer being added is contained in only one label.

If two or more labels are being pushed onto a packet, the PHB layer being added is marked with the same MPLS EXP field in all of the label entries being pushed on at that time.

Tunneling Modes Operation



Note Cisco IOS allows a flexible configuration. You can configure the PHB definition of the MPLS EXP field differently from the PHB definition of the IP Precedence and DSCP.

A service provider may or may not care about the PHB marking of their customer's packet. For example, in customer C1's network, an IP Precedence value of 5 may mean voice. In customer C2's network, an IP Precedence value of 3 may mean voice. The service provider does not want to have two different IP Precedence values for voice. If the service provider has a large number of customers, there could be "many" values for voice. There are only eight possible EXP values.

To deal with different IP Precedence values representing the same PHB (in our example, for voice), the service provider does the following:

1. Arbitrarily chooses a common MPLS EXP field value to represent a PHB. For example, 2 can represent voice.
2. Looks at the packets of each customer. The service provider may look at the IP Precedence field value or at the UDP port number for voice, which is constant in every network.
3. For all customers, sets each voice packet to the MPLS EXP field value 2 on all the service provider's customer ports. Consequently, each router in the service provider's network only has to look for the MPLS EXP field value 2 for voice.

Another solution would be to set the DSCP value to 2, but that would alter the customer's PHB. MPLS DiffServ tunneling modes achieve the same results without altering the DSCP value.

This section illustrates and describes the following:

Pipe Mode with an Explicit NULL LSP

This section describes the following:

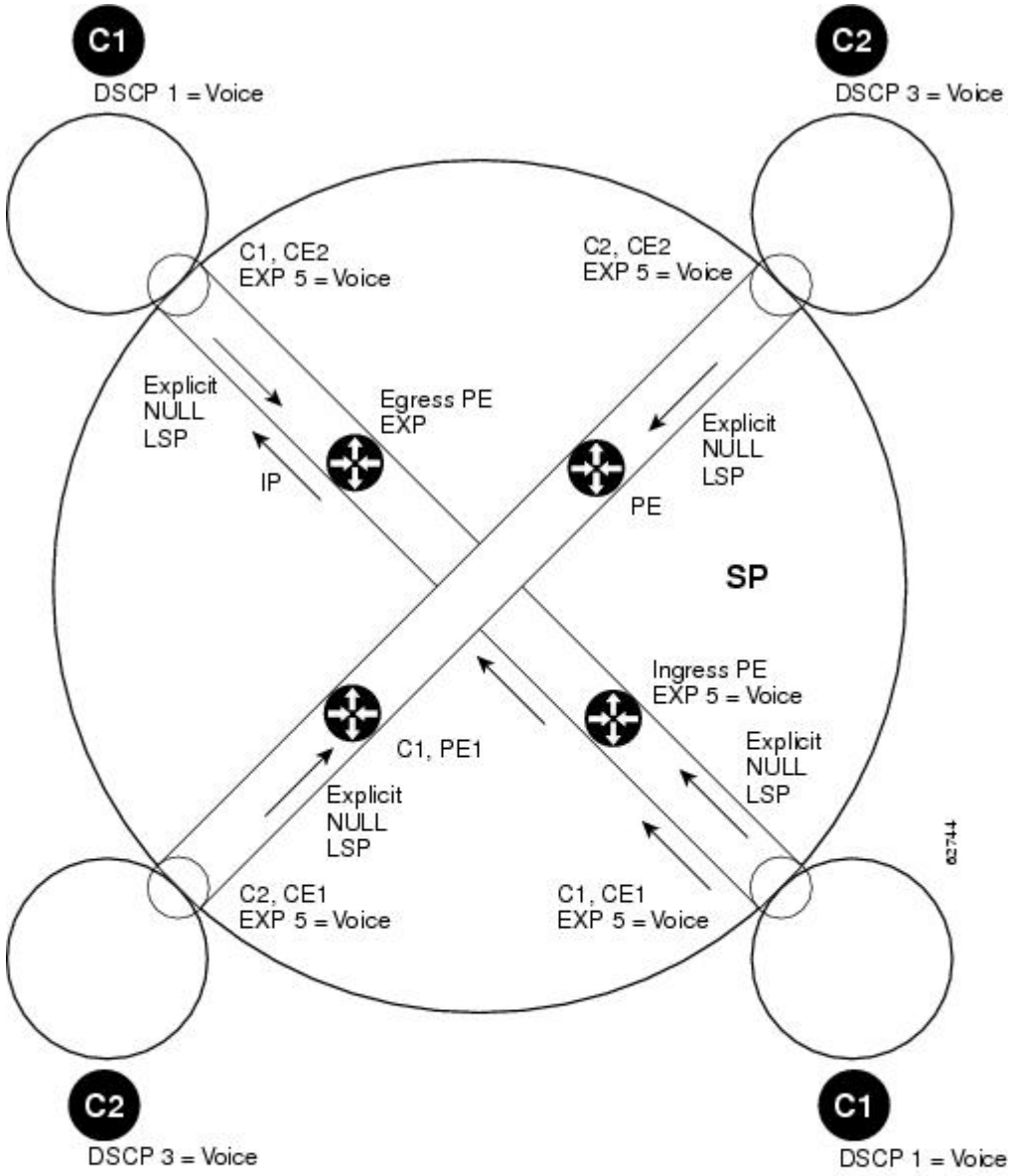
Pipe Mode with an Explicit NULL LSP Overview

Pipe mode with an explicit NULL LSP has the following characteristics:

- The QoS tunnel goes from the ingress CE router through the PE router to the egress CE router.
- There is an explicit NULL LSP from the CE router to the PE router. The label entry contains an MPLS EXP field, but does not carry a label value for forwarding purposes. It contains a zero (a null label value) for all packets going to the ingress PE router.
- The egress PE router removes the label entry and forwards packets as IP, but QoS is done on the output interface based on the MPLS EXP field received by the egress PE router.
- The service provider does not overwrite the IP Precedence value in the service provider's network.

The figure below shows an overview of Pipe mode with an explicit NULL LSP.

Figure 1: Pipe Mode with an Explicit NULL LSP Overview



Symbol	Meaning
C1	Customer 1's DiffServ domain
C2	Customer 2's DiffServ domain
CE1	Customer edge router 1
PE1	Service provider edge router (ingress LSR)
P1	Service provider router within the core of the provider's network
P2	Service provider router within the core of the provider's network
PE2	Service provider's edge router (egress LSR)
CE2	Customer edge router 2
SP	Service provider DiffServ domain

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

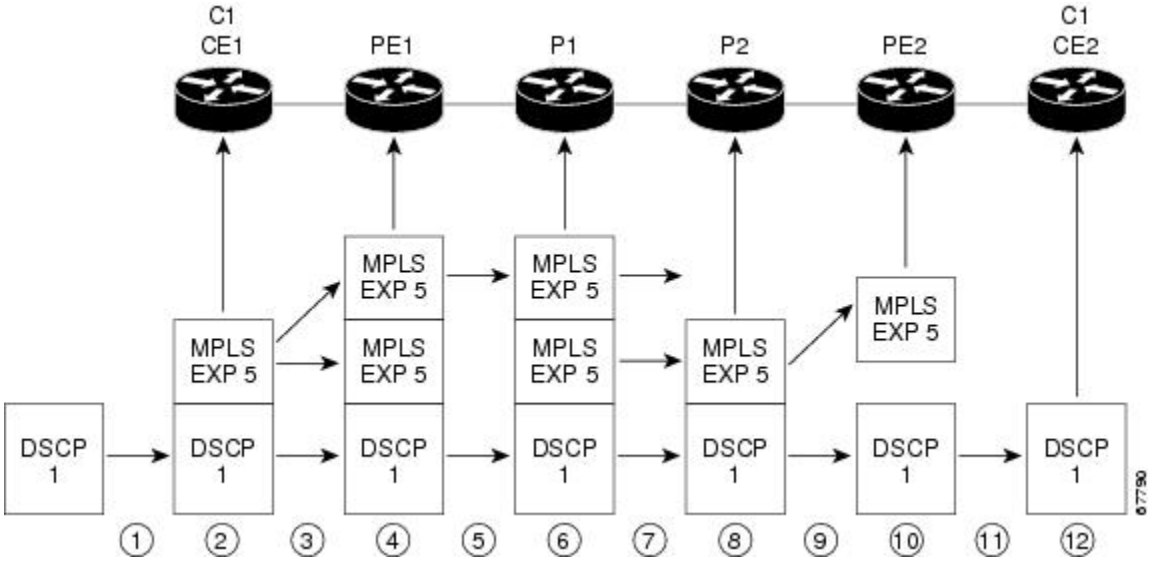
The figure above illustrates the following:

1. An IP packet arrives at C1, CE1 with a DSCP value of 1.
2. C2, CE1 sets the MPLS EXP field value to 5 during label imposition of the null label.
3. The packet goes through the service provider's network with the MPLS EXP field value set to 5.
4. Each router in the service provider's network looks at the MPLS EXP field and does QoS based on that value.
5. When the packet gets to the egress PE router going back into C1's network, it does QoS based on the packet's MPLS EXP field even though the packet is transmitted as an IP packet.

Pipe Mode with an Explicit NULL LSP Operating Procedure

The figure below illustrates the operation of Pipe mode with an explicit NULL LSP for Customer 1, when MPLS VPN is enabled. Since VPN is enabled, there are two MPLS label entries. Otherwise, there would be only one entry. The functionality would be similar for Customer 2, but the DSCP value would be 3.

Figure 2: Pipe Mode with an Explicit NULL LSP Operation with MPLS VPN Enabled



Pipe mode with an explicit NULL LSP functions as follows. The circled numbers at the bottom of the illustration correspond to the step numbers.

1. IP packets arrive at the router CE1, the managed CE router, with a DSCP value of 1.
2. An explicit NULL label entry is imposed onto the packet that contains an EXP value of 5.
3. The packet is transmitted to PE1 on the explicit NULL LSP.

4. The PE1 router saves the value of the MPLS EXP field and removes the explicit NULL entry. The PE1 router then imposes new labels onto the IP packet. Each label entry is set to the saved MPLS EXP field 5.
5. The packet is transmitted to P1.
6. At P1, the received EXP value is copied into the swapped label entry.
7. The packet is transmitted to P2.
8. At P2, the topmost label is popped, exposing a label entry that also has an EXP value of 5.
9. The packet is transmitted to PE2.
10. PE2 stores the value of the MPLS EXP field in the qos-group and discard-class variables, and removes the label entry from the packet.
11. While transmitting the packet to CE2, PE2 does QoS on its egress interface based on the saved value of the MPLS EXP field (qos-group and discard-class).
12. The IP packet arrives at the CE2 router.

Short Pipe Mode

This section describes the following:

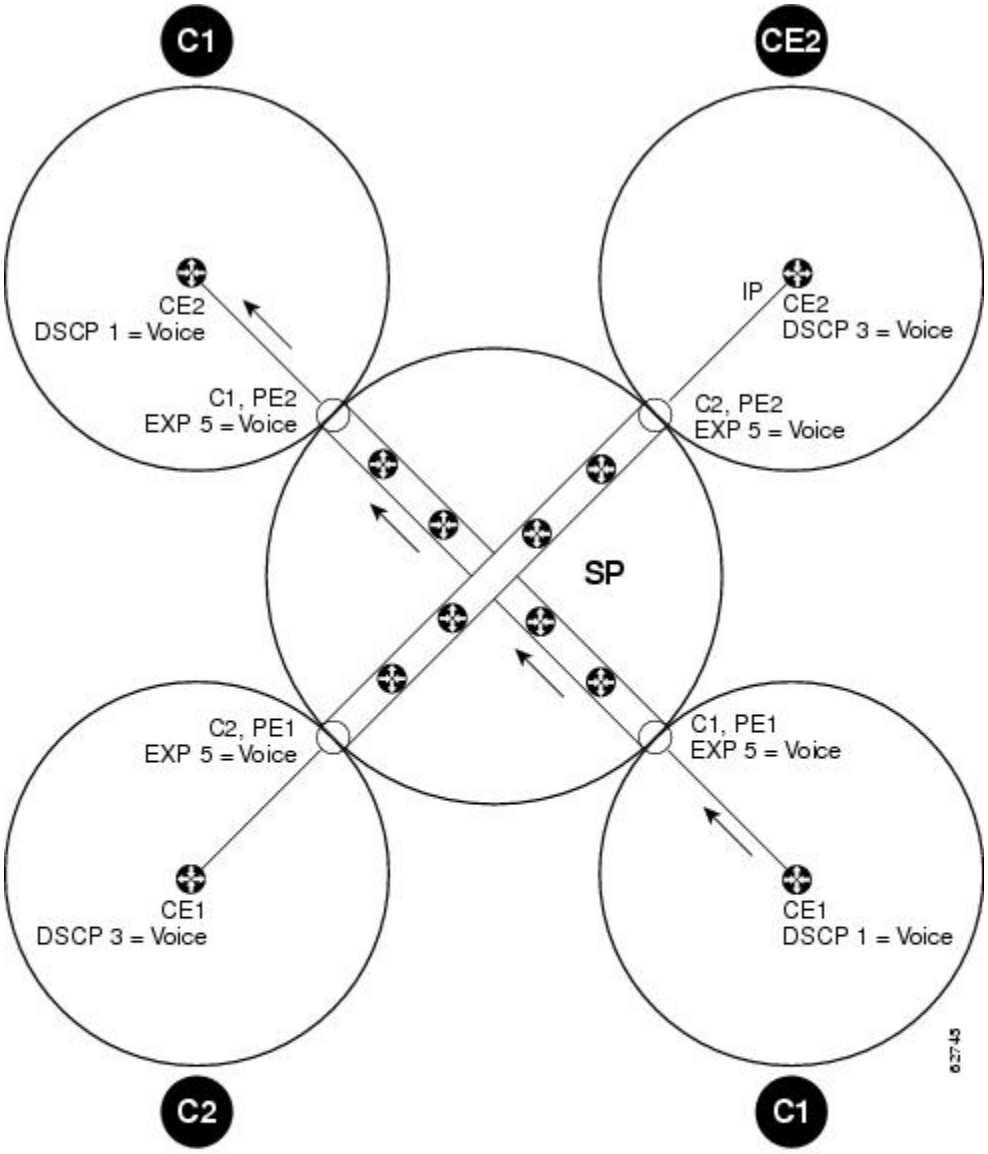
Short Pipe Mode Overview

Short Pipe mode has the following characteristics:

- The QoS tunnel goes from the ingress PE router to the egress PE router.
- The egress PE router transmits packets as IP and QoS is done on the output interface based on the IP DSCP or IP Precedence value.
- The service provider does not overwrite the DSCP or IP Precedence value in the service provider's network.

The figure below shows an overview of Short Pipe mode.

Figure 3: Short Pipe Mode Overview



Symbol	Meaning
C1	Customer 1's DiffServ domain
C2	Customer 2's DiffServ domain
CE1	Customer edge router 1
PE1	Service provider edge router (ingress LSR)
P1	Service provider router within the core of the provider's network
P2	Service provider router within the core of the provider's network
PE2	Service provider's edge router (egress LSR)
CE2	Customer edge router 2
SP	Service provider DiffServ domain

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

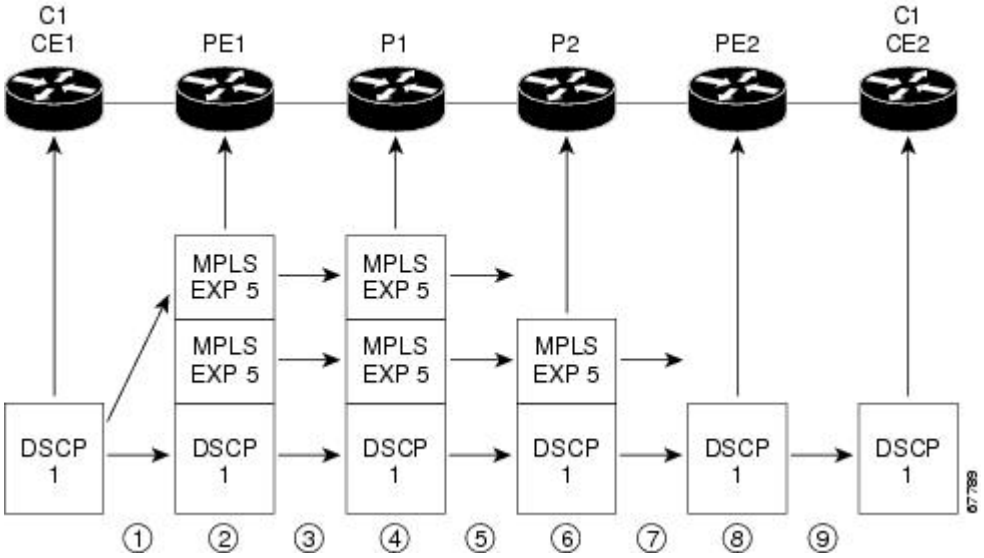
The figure above shows the following:

1. An IP packet arrives at C1, CE1 with a DSCP value of 1.
2. C1, CE1 transmits the IP packet to C1, PE1.
3. C1, PE1 sets the MPLS EXP field value to 5 during label imposition of the VPN label entries.
4. The packet goes through the service provider's network with the MPLS EXP field value set to 5.
5. Each router in the service provider's network looks at the MPLS EXP field and does QoS based on that value.
6. When the packet gets to the egress PE router going back into C1's network, it does QoS based on the IP DSCP field.

Short Pipe Mode Operating Procedure

The figure below illustrates Short Pipe mode.

Figure 4: Short Pipe Mode Operation



Short Pipe mode functions as follows. The circled numbers at the bottom of the illustration correspond to the step numbers.

1. C1, CE1 transmits an IP packet to PE1 with an IP DSCP value of 1.
2. PE1 sets the MPLS EXP field to 5 in the imposed label entries.
3. PE1 transmits the packet to P1.
4. P1 sets the MPLS EXP field value to 5 in the swapped label entry.
5. P1 transmits the packet to P2.
6. P2 pops the IGP label entry.
7. P2 transmits the packet to PE2.

8. PE2 pops the BGP label.
9. PE2 transmits the packet to C1, CE2, but does QoS based on the IP DSCP value.

Uniform Mode

This section describes the following:

Uniform Mode Overview

In a label, the MPLS EXP field is not the same as the label value.

The topmost label entry contains the following:

- Label value, which contains labels and other information, to forward the packet.
- MPLS EXP field, which only pertains to the QoS of the packet, not the route. The EXP field value is not advertised. Its value comes from the way that the packet is received.

In Uniform mode, packets are treated uniformly in the IP and MPLS networks; that is, the IP Precedence value and the MPLS EXP bits always are identical. Whenever a router changes or recolors the PHB of a packet, that change must be propagated to all encapsulation markings. The propagation is performed by a router only when a PHB is added or exposed due to label imposition or disposition on any router in the packet's path. The color must be reflected everywhere, at all levels. For example, if a packet's QoS marking is changed in the MPLS network, the IP QoS marking reflects that change.

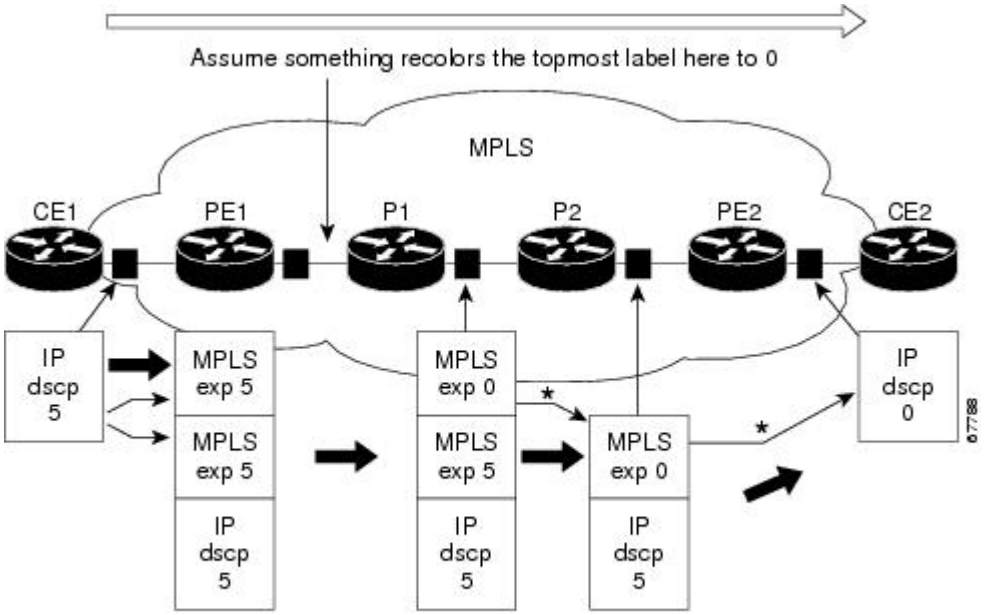
Uniform mode functions as follows:

- In both the MPLS-to-MPLS path and the MPLS-to-IP path, the PHBs of the topmost popped label are copied into the new top label or into the IP DSCP if no label remains.
- There can be a maximum of eight PHBs.
- If the PHBs are enclosed using more than the three Precedence bits, you must map DSCP to MPLS at the entry to the MPLS cloud.
- When packets leave the MPLS cloud, you must remap from the MPLS EXP value to the DSCP field in the IP header.

Uniform Mode Operating Procedure

The figure below illustrates the operation of Uniform mode.

Figure 5: Uniform Mode Operation



*In both the MPLS-to-MPLS and the MPLS-to-IP cases, the PHBs of the topmost popped label is copied into the new top label or the IP DSCP if no label remains

The procedure varies according to whether there are IP Precedence bit markings or DSCP markings.

The following actions occur if there are IP Precedence bit markings:

1. IP packets arrive in the MPLS network at PE1, the service provider edge router.
2. A label is copied onto the packet.
3. If the MPLS EXP field value is recolored (for example, if the packet becomes out-of-rate because too many packets are being transmitted), that value is copied to the IGP label. The value of the BGP label is not changed.
4. At the penultimate hop, the IGP label is removed. That value is copied into the next lower level label.
5. When all MPLS labels have been removed from the packet which is sent out as an IP packet, the IP Precedence or DSCP value is set to the last changed EXP value in the core.

Following is an example when there are IP precedence bit markings:

1. At CE1 (customer equipment 1), the IP packet has an IP Precedence value of 5.
2. When the packet arrives in the MPLS network at PE1 (the service provider edge router), the IP Precedence value of 5 is copied to the imposed label entries of the packet.
3. The MPLS EXP field in the IGP label header might be changed within the MPLS core (for example, at P1).

Note Since the IP Precedence bits are 5, the BGP label and the IGP label also contain 5 because in Uniform mode the labels always are identical. The packet is treated uniformly in the IP and MPLS networks.

1. At P2, when the IGP label is removed, the MPLS EXP field in this label entry is copied into the underlaying BGP label.
2. At PE2, when the BGP label is popped, the EXP field in this label header is copied into the IP Precedence field of the underlying IP header.

How to Configure MPLS DiffServ Tunneling Modes



Note You can configure only one of the tunneling modes.

Determining Which Tunneling Mode is Appropriate

- If there are managed customer edge (CE) routers, we recommend that you use Pipe mode with an explicit NULL LSP so that there is service provider PHB on the PE-to-CE link.
- If there is no managed CE router, we recommend that you use Short Pipe mode.
- If there are no markings or few markings, customers are likely to use Uniform mode.

Setting the MPLS EXP field

There are two ways to set the MPLS EXP field:

- Use the set mpls experimental topmost command to set the topmost label entry's value directly in the packet on the input and/or output interfaces.
- Use the set mpls experimental imposition command on the input interface to set the pushed label entry's value during label imposition.

By default, the label edge router copies the IP Precedence of the IP packet to the MPLS EXP field in all pushed label entries.

You can optionally map the IP Precedence or DSCP field to the MPLS EXP field in the MPLS header by using the **set mpls experimental imposition** command.

Configuring Pipe Mode with an Explicit NULL LSP

This section describes how to configure the following:

For examples, see the Pipe Mode with an Explicit NULL LSP Configuration Example, on page 39.



Note The steps that follow show one way, but not the only way, to configure Pipe Mode with an Explicit NULL LSP.

Ingress CE Router--Customer Facing Interface

This procedure configures a policy map to set the MPLS EXP field in imposed label entries.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match ip dscp** *dscp-values*
3. **policy-map** *name*
4. **class** *class-name*
5. **police** *bps* [*burst-normal*] [*burst-max*] **conform-action** *action* **exceed-action** *action* [**violate-action***action*]
6. **interface** *type slot /port*
7. **service-policy input** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map IP-AF11`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.
Step 2	**match ip dscp** *dscp-values* **Example:** `Router(config-c-map)# match ip dscp 4`	Uses the DSCP values as the match criteria for control plane traffic and other traffic that will be transmitted as IP.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map set-MPLS-PHB`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class IP-AF11`	Associates the traffic class with the service policy.
Step 5	**police** *bps* [*burst-normal*] [*burst-max*] **conform-action** *action* **exceed-action** *action* [**violate-action***action*] **Example:** `Router(config-p-map-c)# police 8000 conform-action set-mpls-experimental-imposition-transmit 4 exceed-action set-mpls-experimental-imposition-transmit 2`	Configures the Traffic Policing feature, including the following: • Action to take on packets that conform to the rate limit specified in the SLA (service level agreement) • Action to take on packets that exceed the rate limit specified in the SLA

	Command or Action	Purpose
		At the action field, enter **set-mpls-experimental-imposition** *value*, where *value*is the value to which the MPLS EXP field will be set.
Step 6	**interface** *type slot /port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.
Step 7	**service-policy input** *name* **Example:** `Router(config-if)# service-policy input set-MPLS-PHB`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets coming into the interface.

Ingress CE Router--PE Facing Interface

This procedure classifies packets based on their MPLS EXP field and provides appropriate discard and scheduling treatments.

SUMMARY STEPS

1. **class-map match-any** *class-name*
2. **match mpls experimental topmost** *mpls-values*
3. **match ip dscp** *dscp-values*
4. **policy-map** *name*
5. **class** *class-name*
6. **bandwidth** {*bandwidth-kbps* | **percent** *percent*}
7. **random-detect**
8. **interface** *type slot/port*
9. **service-policy output** *name*
10. **mpls ip encapsulate explicit-null**

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map match-any** *class-name* **Example:** `Router(config)# class-map match-any MPLS-AF1`	Specifies that packets must meet one of the match criteria to be considered a member of the traffic class.
Step 2	**match mpls experimental topmost** *mpls-values* **Example:**	Matches up to eight MPLS EXP field values. Puts matching packets into the same class.

	Command or Action	Purpose
	`Router(config-c-map)# match mpls experimental topmost 2 4`	
Step 3	**match ip dscp** *dscp-values* **Example:** `Router(config-c-map)# match ip dscp 4`	Uses the DSCP values as the match criteria for control plane traffic and other traffic that will be transmitted as IP.
Step 4	**policy-map** *name* **Example:** `Router(config)# policy-map output-qos`	Configures the QoS policy for packets that match the class or classes.
Step 5	**class** *class-name* **Example:** `Router(config-p-map)# class MPLS-AF1`	Associates the traffic class with the service policy.
Step 6	**bandwidth** {*bandwidth-kbps* | **percent** *percent*} **Example:** `Router(config-p-map-c)# bandwidth percent 40`	Specifies the minimum bandwidth guarantee to a traffic class. You can specify the minimum bandwidth guarantee in kilobits per second or by percent of the overall bandwidth.
Step 7	**random-detect** **Example:** `Router(config-p-map-c)# random-detect`	Applies WRED to the policy based on the IP Precedence or the MPLS EXP field value.
Step 8	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.
Step 9	**service-policy output** *name* **Example:** `Router(config-if)# service-policy output output-qos`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets leaving the interface.
Step 10	**mpls ip encapsulate explicit-null** **Example:** `Router(config-if)# mpls ip encapsulate explicit-null`	Encapsulates with an explicit NULL label header all packets forwarded from the interface or subinterface.

Ingress PE Router--P Facing Interface

In this procedure, the default label swap behavior copies the received MPLS EXP field value to the output MPLS EXP field.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match mpls experimental topmost** *mpls-values*
3. **policy-map** *name*
4. **class** *class-name*
5. **bandwidth** {*bandwidth-kbps* | **percent** *percent*}
6. **random-detect**
7. **interface** *type slot/port*
8. **service-policy output** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map MPLS-AF1`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.
Step 2	**match mpls experimental topmost** *mpls-values* **Example:** `Router(config-c-map)# match mpls experimental topmost 2 4`	Specifies the MPLS values to use as match criteria against which packets are checked to determine if they belong to the class.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map output-qos`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class MPLS-AF1`	Associates the traffic class with the service policy.
Step 5	**bandwidth** {*bandwidth-kbps* | **percent** *percent*} **Example:** `Router(config-p-map-c)# bandwidth percent 40`	Specifies the minimum bandwidth guarantee to a traffic class. You can specify the minimum bandwidth guarantee in kilobits per second or by percent of the overall bandwidth.

	Command or Action	Purpose
Step 6	**random-detect** **Example:** `Router(config-p-map-c)# random-detect`	Applies WRED to the policy based on the IP Precedence or the MPLS EXP field value.
Step 7	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.
Step 8	**service-policy output** *name* **Example:** `Router(config-if)# service-policy output output-qos`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets leaving the interface.

P Router--P Facing Interface

This procedure classifies packets based on their MPLS EXP field and provides appropriate discard and scheduling treatments.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match mpls experimental topmost** *mpls-values*
3. **policy-map** *name*
4. **class** *class-name*
5. **set mpls experimental topmost** *value*
6. **bandwidth** {*bandwidth-kbps* | **percent** *percent*}
7. **random-detect**
8. **interface** *type slot/port*
9. **service-policy output** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map MPLS-AF1`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.

	Command or Action	Purpose
Step 2	**match mpls experimental topmost** *mpls-values* **Example:** `Router(config-c-map)# match mpls experimental topmost 2 4`	Specifies the MPLS EXP field values used as a match criteria against which packets are checked to determine if they belong to the class.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map output-qos`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class MPLS-AF1`	Associates the traffic class with the service policy.
Step 5	**set mpls experimental topmost** *value* **Example:** `Router(config-p-map-c)# set mpls experimental topmost 3`	Sets the MPLS EXP field value in the topmost MPLS label header at the input and/or output interfaces. This command is optional.
Step 6	**bandwidth** {*bandwidth-kbps* | **percent** *percent*} **Example:** `Router(config-p-map-c)# bandwidth percent 40`	Specifies the minimum bandwidth guarantee to a traffic class. You can specify the minimum bandwidth guarantee in kilobits per second or by percent of the overall bandwidth.
Step 7	**random-detect** **Example:** `Router(config-p-map-c)# random-detect`	Applies WRED to the policy based on the IP Precedence or the MPLS EXP field value.
Step 8	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.
Step 9	**service-policy output** *name* **Example:** `Router(config-if)# service-policy output output-qos`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets leaving the interface.

Egress PE Router--P Facing Interface

In this procedure, the qos-group and discard-class convey a packet's PHB to the output interface. The qos-group and discard-class will be used for QoS classification and then will be discarded. The output IP packet's ToS field will not be overwritten.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match mpls experimental topmost** *mpls-values*
3. **policy-map** *name*
4. **class** *class-name*
5. **set qos-group** *qos-group-value*
6. **set discard-class** *value*
7. **interface** *type slot/port*
8. **service-policy input** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map MPLS-AF11`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.
Step 2	**match mpls experimental topmost** *mpls-values* **Example:** `Router(config-c-map)# match mpls experimental topmost 4`	Specifies the packet characteristics that will be matched to the class.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map set-PHB`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class MPLS-AF11`	Associates the traffic class with the service policy.
Step 5	**set qos-group** *qos-group-value* **Example:** `Router(config-p-map-c)# set qos-group 1`	Sets a group ID that can be used later to classify packets. Valid values are from 0 to 99.
Step 6	**set discard-class** *value* **Example:** `Router(config-p-map-c)# set discard-class 1`	Marks a packet with a discard-class value. Specifies the type of traffic that will be dropped when there is congestion. Valid values are from 0 to 7.

	Command or Action	Purpose
Step 7	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.
Step 8	**service-policy input** *name* **Example:** `Router(config-if)# service-policy input set-PHB`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets coming into the interface.

Egress PE Router--Customer Facing Interface

This procedure classifies a packet according to the QoS group ID and determines a packet's discard treatment according to the discard-class attribute.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match qos-group** *qos-group-value*
3. **policy-map** *name*
4. **class** *class-name*
5. **bandwidth** {*bandwidth-kbps* | **percent** *percent*}
6. **random-detect discard-class-based**
7. **interface** *type slot/port*
8. mpls ip
9. **service-policy output** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map Local-AF1`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.
Step 2	**match qos-group** *qos-group-value* **Example:** `Router(config-c-map)# match qos-group 1`	Identifies a specified QoS group value as a match criteria.
Step 3	**policy-map** *name* **Example:**	Configures the QoS policy for packets that match the class or classes.

	Command or Action	Purpose
	`Router(config)# policy-map output-qos`	
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class Local-AF1`	Associates the traffic class with the service policy.
Step 5	**bandwidth** {*bandwidth-kbps* | **percent** *percent*} **Example:** `Router(config-p-map-c)# bandwidth percent 40`	Specifies the minimum bandwidth guarantee to a traffic class. You can specify the minimum bandwidth guarantee in kilobits per second or by percent of the overall bandwidth.
Step 6	**random-detect discard-class-based** **Example:** `Router(config-p-map-c)# random-detect discard-class-based`	Bases WRED on the discard class value of a packet.
Step 7	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.
Step 8	mpls ip **Example:** `Router(config-if)# mpls ip`	Enables MPLS forwarding of IP version 4 (IPv4) packets along normally routed paths for a particular interface. **Note** You must issue the **mpls ip**command on this interface to receive packets with an explicit-NULL label from the CE router. The **mpls ip** command is not configured on the CE router's interface connected to this interface and therefore no LDP nor other label distribution protocol sessions will be established on this link.
Step 9	**service-policy output** *name* **Example:** `Router(config-if)# service-policy output output-qos`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets leaving the interface.

Configuring Short Pipe Mode

This section describes how to configure the following:

For examples, see the Short Pipe Mode Configuration Example, on page 40.

Note The steps that follow show one way, but not the only way, to configure Short Pipe mode.

Ingress PE Router--Customer Facing Interface

This procedure configures a policy map to set the MPLS EXP field in imposed label entries.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match ip dscp** *dscp-values*
3. **policy-map** *name*
4. **class** *class-name*
5. **police** *bps* [*burst-normal*] [*burst-max*] **conform-action** *action* **exceed-action** *action* [**violate-action** *action*]
6. **interface** *type slot/port*
7. **service-policy input** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map IP-AF11`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.
Step 2	**match ip dscp** *dscp-values* **Example:** `Router(config-c-map)# match ip dscp 4`	Uses the DSCP values as the match criteria.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map set-MPLS-PHB`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class IP-AF11`	Associates the traffic class with the service policy.
Step 5	**police** *bps* [*burst-normal*] [*burst-max*] **conform-action** *action* **exceed-action** *action* [**violate-action** *action*] **Example:** `Router(config-p-map-c)# police 8000 conform-action set-mpls-experimental-imposition-transmit 4 exceed-action set-mpls-experimental-imposition-transmit 2`	Configures the Traffic Policing feature, including the following: • Action to take on packets that conform to the rate limit specified in the SLA. • Action to take on packets that exceed the rate limit specified in the SLA.

	Command or Action	Purpose
		At the action field, enter **set-mpls-experimental-imposition** *value*, where *value*is the value to which the MPLS EXP field will be set.
Step 6	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.
Step 7	**service-policy input** *name* **Example:** `Router(config-if)# service-policy input set-MPLS-PHB`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets coming into the interface.

Ingress PE Router--P Facing Interface

This procedure classifies packets based on their MPLS EXP field and provides appropriate discard and scheduling treatments.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match mpls experimental topmost** *mpls-values*
3. **policy-map** *name*
4. **class** *class-name*
5. **bandwidth** {*bandwidth-kbps* | **percent** *percent*}
6. **random-detect**
7. **interface** *type slot/port*
8. **service-policy output** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map MPLS-AF1`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.
Step 2	**match mpls experimental topmost** *mpls-values* **Example:** `Router(config-c-map)# match mpls experimental topmost 2 4`	Specifies the MPLS EXP field values used as a match criteria against which packets are checked to determine if they belong to the class.

	Command or Action	Purpose
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map output-qos`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class MPLS-AF1`	Associates the traffic class with the service policy.
Step 5	**bandwidth** {*bandwidth-kbps* | **percent** *percent*} **Example:** `Router(config-p-map-c)# bandwidth percent 40`	Specifies the minimum bandwidth guarantee to a traffic class. You can specify the minimum bandwidth guarantee in kilobits per second or by percent of the overall bandwidth.
Step 6	**random-detect** **Example:** `Router(config-p-map-c)# random-detect`	Enables a WRED drop policy for a traffic class that has a bandwidth guarantee.
Step 7	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.
Step 8	**service-policy output** *name* **Example:** `Router(config-if)# service-policy output-qos`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets leaving the interface.

P Router--P Facing Interface

This procedure classifies packets based on their MPLS EXP field and provides appropriate discard and scheduling treatments.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match mpls experimental topmost** *mpls-values*
3. **policy-map** *name*
4. **class** *class-name*
5. **bandwidth** {*bandwidth-kbps* | **percent** *percent*}
6. **random-detect**
7. **interface** *type slot/port*
8. **service-policy output** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map MPLS-AF1`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.
Step 2	**match mpls experimental topmost** *mpls-values* **Example:** `Router(config-c-map)# match mpls experimental topmost 2 4`	Specifies the MPLS EXP field values used as a match criteria against which packets are checked to determine if they belong to the class.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map output-qos`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class MPLS-AF1`	Associates the traffic class with the service policy.
Step 5	**bandwidth** {*bandwidth-kbps* | **percent** *percent*} **Example:** `Router(config-p-map-c)# bandwidth percent 40`	Specifies the minimum bandwidth guarantee to a traffic class. You can specify the minimum bandwidth guarantee in kilobits per second or by percent of the overall bandwidth.
Step 6	**random-detect** **Example:** `Router(config-p-map-c)# random-detect`	Applies WRED to the policy based on the IP Precedence or the MPLS EXP field value.
Step 7	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.
Step 8	**service-policy output** *name* **Example:** `Router(config-if)# service-policy output output-qos`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets leaving the interface.

Egress PE Router--Customer Facing Interface

This procedure classifies a packet based on its IP DSCP value and provides appropriate discard and scheduling treatments.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match ip dscp** *dscp-values*
3. **policy-map** *name*
4. **class** *class-name*
5. **bandwidth** {*bandwidth-kbps* | **percent** *percent*}
6. **random-detect dscp-based**
7. **interface** *type slot/port*
8. **service-policy output** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map IP-AF1`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.
Step 2	**match ip dscp** *dscp-values* **Example:** `Router(config-c-map)# match ip dscp 4 0`	Uses the DSCP values as the match criteria.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map output-qos`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class AF1`	Associates the traffic class with the service policy.
Step 5	**bandwidth** {*bandwidth-kbps* | **percent** *percent*} **Example:** `Router(config-p-map-c)# bandwidth percent 40`	Specifies the minimum bandwidth guarantee to a traffic class. You can specify the minimum bandwidth guarantee in kilobits per second or by percent of the overall bandwidth.
Step 6	**random-detect dscp-based** **Example:**	Enables a WRED drop policy for a traffic class that has a bandwidth guarantee.

	Command or Action	Purpose
	`Router(config-p-map-c)# random-detect dscp-based`	
Step 7	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.
Step 8	**service-policy output** *name* **Example:** `Router(config-if)# service-policy output output-qos`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets leaving the interface.

Configuring Uniform Mode

This section describes how to configure the following:

For examples, see the Uniform Mode Configuration Example, on page 42.

Note The steps that follow show one way, but not the only way, to configure Uniform mode.

Ingress PE Router--Customer Facing Interface

This procedure configures a policy map to set the MPLS EXP field in imposed label entries.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match ip dscp** *dscp-values*
3. **policy-map** *name*
4. **class** *class-name*
5. **police** *bps* [*burst-normal*] [*burst-max*] **conform-action** *action* **exceed-action** *action* [**violate-action** *action*]
6. **interface** *type slot/port*
7. **service-policy input** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:**	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.

	Command or Action	Purpose
	`Router(config)# class-map IP-AF11`	
Step 2	**match ip dscp** *dscp-values* **Example:** `Router(config-c-map)# match ip dscp 4`	Uses the DSCP values as the match criteria.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map set-MPLS-PHB`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class IP-AF11`	Associates the traffic class with the service policy.
Step 5	**police** *bps* [*burst-normal*] [*burst-max*] **conform-action** *action* **exceed-action** *action* [**violate-action** *action*] **Example:** `Router(config-p-map-c)# police 8000 conform-action set-mpls-experimental-imposition-transmit 3 exceed-action set-mpls-experimental-imposition-transmit 2`	Configures the Traffic Policing feature, including the following: • Action to take on packets that conform to the rate limit specified in the SLA. • Action to take on packets that exceed the rate limit specified in the SLA. At the action field, enter **set-mpls-experimental-imposition** *value,*where *value* is the value to which the MPLS EXP field will be set.
Step 6	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.
Step 7	**service-policy input** *name* **Example:** `Router(config-if)# service-policy input set-MPLS-PHB`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets coming into the interface.

Ingress PE Router--P Facing Interface

This procedure classifies packets based on their MPLS EXP field and provides appropriate discard and scheduling treatments.

SUMMARY STEPS

1. **class-map** *class-name*

2. **match mpls experimental topmost** *mpls-values*
3. **policy-map** *name*
4. **class** *class-name*
5. **bandwidth** {*bandwidth-kbps* | **percent** *percent*}
6. **random-detect**
7. **interface** *type slot/port*
8. **service-policy output** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map MPLS-AF1`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.
Step 2	**match mpls experimental topmost** *mpls-values* **Example:** `Router(config-c-map)# match mpls experimental topmost 2 3`	Specifies the MPLS EXP field values used as a match criteria against which packets are checked to determine if they belong to the class.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map output-qos`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class MPLS-AF1`	Associates the traffic class with the service policy.
Step 5	**bandwidth** {*bandwidth-kbps* | **percent** *percent*} **Example:** `Router(config-p-map-c)# bandwidth percent 40`	Specifies the minimum bandwidth guarantee to a traffic class. You can specify the minimum bandwidth guarantee in kilobits per second or by percent of the overall bandwidth.
Step 6	**random-detect** **Example:** `Router(config-p-map-c)# random-detect`	Enables a WRED drop policy for a traffic class that has a bandwidth guarantee.
Step 7	**interface** *type slot/port* **Example:**	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.

	Command or Action	Purpose
	`Router(config)# interface ethernet 3/0`	
Step 8	**service-policy output** *name* **Example:** `Router(config-if)# service-policy output-qos`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets leaving the interface.

P Router--Upstream P Facing Interface

This procedure classifies a packet based on the MPLS EXP field and sets the QoS group ID.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match mpls experimental topmost** *mpls-values*
3. **policy-map** *name*
4. **class** *class-name*
5. **set qos-group mpls experimental topmost**
6. **interface** *type slot/port*
7. **service-policy input** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map mpls-in`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.
Step 2	**match mpls experimental topmost** *mpls-values* **Example:** `Router(config-c-map)# match mpls experimental topmost 4 5`	Specifies the MPLS EXP field values used as a match criteria against which packets are checked to determine if they belong to the class.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map policy2`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:**	Associates the traffic class with the service policy.

	Command or Action	Purpose
	`Router(config-p-map)# class mpls-in`	
Step 5	**set qos-group mpls experimental topmost** **Example:** `Router(config-p-map-c)# set qos-group mpls experimental topmost`	Copies the MPLS EXP topmost field value into the QoS group ID. For more information, refer to *Enhanced Packet Marking* , Release 12.2(13)T.
Step 6	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card number, and the backplane slot number.
Step 7	**service-policy input** *name* **Example:** `Router(config-if)# service-policy input policy2`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets coming into the interface.

P Router--Downstream P Facing Interface

This procedure matches packets based on their QoS ID and sets the MPLS EXP field in the topmost label header to the QoS group ID.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match qos-group** *qos-group-value*
3. **policy-map** *name*
4. **class** *class-name*
5. **set mpls experimental topmost qos-group**
6. **bandwidth** {*bandwidth-kbps* | **percent** *percent*}
7. **random-detect**
8. **interface** *type slot/port*
9. **service-policy output** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map qos-group-out`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.

	Command or Action	Purpose
Step 2	**match qos-group** *qos-group-value* **Example:** `Router(config-c-map)# match qos-group 4`	Identifies a specified QoS group value as a match criterion.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map policy3`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class qos-group-out`	Associates the traffic class with the service policy.
Step 5	**set mpls experimental topmost qos-group** **Example:** `Router(config-p-map-c)# set mpls experimental topmost qos-group`	Copies the QoS group ID into the MPLS EXP field of the topmost label header.
Step 6	**bandwidth** {*bandwidth-kbps* | **percent** *percent*} **Example:** `Router(config-p-map-c)# bandwidth percent 40`	Specifies the minimum bandwidth guarantee to a traffic class. You can specify the minimum bandwidth guarantee in kilobits per second or by percent of the overall bandwidth.
Step 7	**random-detect** **Example:** `Router(config-p-map-c)# random-detect`	Applies WRED to the policy based on the IP Precedence or the MPLS EXP field value.
Step 8	**interface** *type slot/port* **Example:** `Router(config)# interface ethernet 3/1`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card numbers, and the backplane slot number.
Step 9	**service-policy output** *name* **Example:** `Router(config-if)# service-policy output policy3`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets coming into the interface.

Egress PE Router--P Facing Interface

This procedure classifies a packet based on the MPLS EXP field and sets the QoS group ID.

SUMMARY STEPS

1. **class-map** *class-name*

2. **match mpls experimental topmost** *mpls-values*
3. **policy-map** *name*
4. **class** *class-name*
5. **set qos-group mpls experimental topmost**
6. **interface** *type slot /port*
7. **service-policy input** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map mpls-in`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.
Step 2	**match mpls experimental topmost** *mpls-values* **Example:** `Router(config-c-map)# match mpls experimental topmost 4 5`	Specifies the MPLS EXP field values used as a match criteria against which packets are checked to determine if they belong to the class.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map foo`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class mpls-in`	Associates the traffic class with the service policy.
Step 5	**set qos-group mpls experimental topmost** **Example:** `Router(config-p-map)# set qos-group mpls experimental topmost`	Copies the MPLS EXP topmost field value into the QoS group ID.
Step 6	**interface** *type slot /port* **Example:** `Router(config)# interface ethernet 3/0`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card numbers, and the backplane slot number.
Step 7	**service-policy input** *name* **Example:** `Router(config-if)# service-policy input foo`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets coming into the interface.

Egress PE Router--Customer Facing Interface

This procedure matches packets based on their QoS ID and sets the IP Precedence field to the QoS group ID.

SUMMARY STEPS

1. **class-map** *class-name*
2. **match qos-group** *qos-group-value*
3. **policy-map** *name*
4. **class** *class-name*
5. **set precedence qos-group**
6. **bandwidth** {*bandwidth-kbps* | **percent** *percent*}
7. **random-detect**
8. **interface** *type slot* /*port*
9. **service-policy output** *name*

DETAILED STEPS

Procedure

	Command or Action	Purpose
Step 1	**class-map** *class-name* **Example:** `Router(config)# class-map qos-out`	Specifies the class-map to which packets will be mapped (matched). Creates a traffic class.
Step 2	**match qos-group** *qos-group-value* **Example:** `Router(config-c-map)# match qos-group 4`	Identifies a specified QoS group value as a match criterion.
Step 3	**policy-map** *name* **Example:** `Router(config)# policy-map foo-out`	Configures the QoS policy for packets that match the class or classes.
Step 4	**class** *class-name* **Example:** `Router(config-p-map)# class qos-out`	Associates the traffic class with the service policy.
Step 5	**set precedence qos-group** **Example:** `Router(config-p-map-c)# set precedence qos-group`	Sets the Precedence value in the packet header.

	Command or Action	Purpose
Step 6	**bandwidth** {*bandwidth-kbps* | **percent** *percent*} **Example:** `Router(config-p-map-c)# bandwidth percent 40`	Specifies the minimum bandwidth guarantee to a traffic class. You can specify the minimum bandwidth guarantee in kilobits per second or by percent of the overall bandwidth.
Step 7	**random-detect** **Example:** `Router(config-p-map-c)# random-detect`	Applies WRED to the policy based on the IP Precedence or the MPLS EXP field value.
Step 8	**interface** *type slot /port* **Example:** `Router(config)# interface ethernet 3/1`	Configures an interface type for Cisco series 7200 and Cisco series 7500 routers. Specifies the type of interface to be configured, the port, connector, or interface card numbers, and the backplane slot number.
Step 9	**service-policy output** *name* **Example:** `Router(config-if)# service-policy output foo-out`	Attaches a QoS policy to an interface and specifies that policies should be applied on packets coming into the interface.

Verifying MPLS DiffServ Tunneling Mode Support

- On PE routers, the **show policy-map interface** command displays the discard-class-based WRED in the output.
- In Short Pipe mode, the **show policy-map interface** command looks for the **set mpls experimental imposition** command.

Troubleshooting Tips

- The IP QoS marking should not change in the service provider's network.
- QoS statistics should indicate that packets were scheduled in the correct classes.

Configuration Examples for MPLS DiffServ Tunneling Modes



Note You can configure only one tunneling mode.

- The examples that follow show one way, but not the only way, to configure the tunneling modes.

Pipe Mode with an Explicit NULL LSP Configuration Example

Ingress CE Router--Customer Facing Interface

In this example, packets are matched to class-map IP-AF11. The DSCP value 4 is used as the match criterion to determine whether a packet belongs to that class. Packets that are conforming have their MPLS EXP field set to 4. Packets that are out-of-rate have their MPLS EXP field set to 2.

```
class-map IP-AF11
 match ip dscp 4
policy-map set-MPLS-PHB
 class IP-AF11
  police 8000 conform-action set-mpls-experimental-imposition-transmit 4 exceed-action
  set-mpls-experimental-imposition-transmit 2
interface ethernet 3/0
 service-policy input set-MPLS-PHB
```

Ingress CE Router--PE Facing Interface

In this example, MPLS EXP 2 and 4 are matched to class-map MPLS-AF1. Packets that match that class have WRED and WFQ enabled.

```
class-map match-any MPLS-AF1
 match mpls experimental topmost 2 4
 match ip dscp 4
policy-map output-qos
class MPLS-AF1
  bandwidth percent 40
  random-detect
interface ethernet 3/0
 service-policy output output-qos
 mpls ip encapsulate explicit-null
```

Ingress PE Router--P Facing Interface

In this example, the default label swap behavior copies the received MPLS EXP field value to the output MPLS EXP field. Packets that have an MPLS EXP value of 2 and 4 are matched to class-map MPLS-AF1. Packets that match that class have WRED and WFQ enabled.

```
class-map MPLS-AF1
 match mpls experimental topmost 2 4
policy-map output-qos
 class MPLS-AF1
   bandwidth percent 40
   random-detect
interface ethernet 3/0
 service-policy output output-qos
```

P Router--P Facing Interface

In this example, packets that have an MPLS EXP value of 2 or 4 are matched to class-map MPLS-AF1. Packets that match that class have WRED and WFQ enabled.

```
class-map MPLS-AF1
 match mpls experimental topmost 2 4
policy-map output-qos
```

```
 class MPLS-AF1
  bandwidth percent 40
  random-detect
interface ethernet 3/0
 service-policy output output-qos
```

Egress PE Router--P Facing Interface

In this example, qos-group 1 and discard-class 1 must be set to indicate the packet's PHB. The qos-group and discard-class are used for QoS classification at the output interface.

```
class-map MPLS-AF11
 match mpls experimental topmost 4
class-map MPLS-AF12
 match mpls experimental topmost 2
policy-map set-PHB
 class MPLS-AF11
  set qos-group 1
  set discard-class 1
class MPLS-AF12
  set qos-group 1
  set discard-class 2
interface ethernet 3/0
 service-policy input set-PHB
```

Egress PE Router--Customer Facing Interface

In this example, packets that have a qos-group value of 1 are matched to class-map Local-AF1. Packets that match that class have WRED based on their discard class value applied.

Note You must issue the **mpls ip** command on this interface to receive packets with an explicit-NULL label from the CE router. The **mpls ip** command is not configured on the CE router's interface connected to this interface and therefore no LDP nor other label distribution protocol sessions will be established on this link.

```
class-map Local-AF1
 match qos-group 1
policy-map output-qos
 class Local-AF1
  bandwidth percent 40
  random-detect discard-class-based
interface ethernet 3/0
 mpls ip
 service-policy output output-qos
```

Short Pipe Mode Configuration Example

Note Short Pipe mode is not configured on CE routers.

Ingress PE Router--Customer Facing Interface

In this example, IP packets are matched to class-map IP-AF11. Packets that are conforming have their MPLS EXP field set to 4. Packets that are out-of-rate have their MPLS EXP field set to 2.

```
class-map IP-AF11
 match ip dscp 4
policy-map set-MPLS-PHB
 class IP-AF11
  police 8000 conform-action set-mpls-experimental-imposition-transmit 4 exceed-action
  set-mpls-experimental-imposition-transmit 2
interface ethernet 3/0
 service-policy input set-MPLS-PHB
```

Ingress PE Router--P Facing Interface

In this example, MPLS EXP 2 and 4 are matched to class-map MPLS-AF1. Packets that match that class have WRED and WFQ enabled.

```
class-map MPLS-AF1
 match mpls experimental topmost 2 4
policy-map output-qos
 class MPLS-AF1
  bandwidth percent 40
  random-detect
interface ethernet 3/0
 service-policy output output-qos
```

P Router--P Facing Interface

In this example, MPLS EXP 2 and 4 are matched to class-map MPLS-AF1. Packets that match that class have WRED and WFQ enabled.

```
class-map MPLS-AF1
 match mpls experimental topmost 2 4
policy-map output-qos
 class MPLS-AF1
  bandwidth percent 40
  random-detect
interface ethernet 3/0
 service-policy output output-qos
```

Egress PE Router--Customer Facing Interface

In this example, the egress PE router transmits IP packets. Packets are matched to class-map IP-AF1. Packets that match that class have WRED and WFQ enabled.

```
class-map IP-AF1
 match ip dscp 4 0
policy-map output-qos
 class AF1
  bandwidth percent 40
  random-detect dscp-based
interface ethernet 3/0
 service-policy output output-qos
```

Uniform Mode Configuration Example

Ingress PE Router--Customer Facing Interface

In this example, IP packets are matched to class-map IP-AF11. Packets that are conforming have their MPLS EXP field set to 3. Packets that are out-of-rate have their MPLS EXP field set to 2.

```
class-map IP-AF11
 match ip dscp 4
policy-map set-MPLS-PHB
 class IP-AF11
  police 8000 conform-action set-mpls-experimental-imposition-transmit 3 exceed-action
  set-mpls-experimental-imposition-transmit 2
interface ethernet 3/0
 service-policy input set-MPLS-PHB
```

Ingress PE Router--P Facing Interface

In this example, MPLS EXP 2 and 3 are matched to class-map MPLS-AF1. Packets that match that class have WRED and WFQ enabled.

```
class-map MPLS-AF1
 match mpls experimental topmost 2 3
policy-map output-qos
 class MPLS-AF1
  bandwidth percent 40
  random-detect
interface ethernet 3/0
 service-policy output output-qos
```

P Router--Upstream P Facing Interface

At the penultimate P router's input interface where the IGP label is popped, the EXP field value in the IGP label is copied to the QoS group ID. Suppose the MPLS EXP field value in the IGP label was recolored in the core to 4 or 5. In this example, MPLS EXP values 4 and 5 are matched to class-map mpls-in. For packets that match that class, the MPLS EXP value in the IGP label is copied to the QoS group ID.

```
class-map mpls-in
 match mpls experimental topmost 4 5
policy-map policy2
 class mpls-in
  set qos-group mpls experimental topmost
interface ethernet 3/0
 service-policy input policy2
```

P Router--Downstream P Facing Interface

In this example, QoS group IDs 4 and 5 are matched to class-map qos-group-out. For packets that match that class, the MPLS EXP field in the topmost outgoing label is set to the QoS group ID.

```
class-map qos-group-out
 match qos-group 4
 match qos-group 5
policy-map policy3
 class qos-group-out
  set mpls experimental topmost qos-group
```

```
  bandwidth percent 40
  random-detect
interface ethernet 3/1
 service-policy output policy3
```

Egress PE Router--P Facing Interface

In this example, packets with MPLS EXP values 4 or 5 are matched to class-map mpls-in. The EXP field value from the label header is copied to the QoS group ID.

```
class-map mpls-in
 match mpls experimental topmost 4 5
policy-map foo
 class mpls-in
  set qos-group mpls experimental topmost
interface ethernet 3/0
 service-policy input foo
```

Egress PE Router--Customer Facing Interface

In this example, the egress PE router transmits IP packets. QoS group IDs 4 and 5 are matched into class-map qos-out and the IP Precedence field of those packets is set to the QoS group ID.

```
class-map qos-out
 match qos-group 4
 match qos-group 5
policy-map foo-out
 class qos-out
  set precedence qos-group
  bandwidth percent 40
  random-detect
interface ethernet 3/1
 service-policy output foo-out
```

Additional References

Related Documents

Related Topic	Document Title
MPLS Traffic Engineering	MPL S Configuration Guide
QoS	Quality of Service Configuration Guide

Standards

Standard	Title
No new or modified standards are supported by this feature, and support for existing standards has not been modified by this feature.	--

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: http://www.cisco.com/go/mibs

RFCs

RFC	Title
No new or modified RFCs are supported by this feature, and support for existing RFCs has not been modified by this feature.	--

Technical Assistance

Description	Link
The Cisco Support website provides extensive online resources, including documentation and tools for troubleshooting and resolving technical issues with Cisco products and technologies. To receive security and technical information about your products, you can subscribe to various services, such as the Product Alert Tool (accessed from Field Notices), the Cisco Technical Services Newsletter, and Really Simple Syndication (RSS) Feeds. Access to most tools on the Cisco Support website requires a Cisco.com user ID and password.	http://www.cisco.com/techsupport

Feature Information for MPLS DiffServ Tunneling Modes

The following table provides release information about the feature or features described in this module. This table lists only the software release that introduced support for a given feature in a given software release train. Unless noted otherwise, subsequent releases of that software release train also support that feature.

Use Cisco Feature Navigator to find information about platform support and Cisco software image support. To access Cisco Feature Navigator, go to www.cisco.com/go/cfn. An account on Cisco.com is not required.

Table 1: Feature Information for MPLS DiffServ Tunneling Modes

Feature Name	Releases	Feature Information
MPLS DiffServ Tunneling Modes	12.2(13)T 12.2(18)S 12.2(27)SBA 12.2(27)SBB 12.2(28)SB 12.3(2)T Cisco IOS Release IOS XE 2.1 15.4(1)S	The MPLS DiffServ Tunneling Modes feature allows service providers to manage the QoS that a router will provide to an MPLS packet in an MPLS network. In 12.2(13)T, this feature was introduced. In 12.2(18)S, this feature was integrated. In 12.2(27)SBA, this feature was integrated. In 12.2(27)SBB, this feature was integrated. In 12.2(28)SB, this feature was integrated. In 12.3(2)T, this feature was integrated. In Cisco IOS Release IOS XE 2.1, this feature was integrated. In Cisco IOS Release 15.4(1) S, support was added for the Cisco 901S platform.

Glossary

CE router --customer edge router. A router that is part of a customer network and that interfaces to a provider edge (PE) router.

class --Classifies traffic, such as voice. You define a traffic class with the **class-map** command.

class-map --Defines what you want to match in a packet. For example, a class-map may specify voice packets.

core --The MPLS network. At the edges, there are edge routers.

customer network --A network that is under the control of an end customer. A customer network can use private addresses as defined in RFC 1918. Customer networks are logically isolated from each other and from the service provider's network.

DiffServ --Application-level QoS and traffic management in an architecture that incorporates mechanisms to control bandwidth, delay, jitter, and packet loss. Application traffic can be categorized into multiple classes (aggregates), with QoS parameters defined for each class. A typical arrangement would be to categorize traffic into premium, gold, silver, bronze, and best-effort classes.

DSCP --differentiated services code point, or DiffServ code point. A marker in the header of each IP packet that prompts network routers to apply differentiated grades of service to various packet streams. The value in the IP header indicates which PHB is to be applied to the packet.

discard-class --Local variable used to indicate the discard profile.

E-LSP --An LSP in which the QoS of a packet is determined solely by the MPLS EXP field in the MPLS header. E-LSPs are not supported by ATM-LSRs.

edge router --A router that is at the edge of the network. It defines the boundary of the MPLS network. It receives and transmits packets. Also referred to as edge label switch router and label edge router.

egress router --Router at the edge of the network where packets are leaving.

encapsulation --The wrapping of data in a particular protocol header. For example, Ethernet data is wrapped in a specific Ethernet header before network transit.

explicit null label --A label that just has an EXP value. A value of zero (0) represents the explicit NULL label. This label can only be at the bottom of the label stack. It indicates that the label stack must be popped, and the forwarding of the packet must then be based on the IPv4 header. Sometimes there may be requirements to have a label in the stack when no label is required. If you want to retain the MPLS EXP field to the next hop, you use an explicit null.

ingress router --Router at the edge of the network where packets are being received by the network.

IP Precedence field --The first three bits in the header of IP packets. These bits allow you to specify the QoS for an IP packet.

L-LSP --An LSP where a particular mechanism of implementing QoS using DiffServ is used. An LSP in which routers infer the QoS treatment for MPLS packets from the packet label and the EXP bits (or the CLP bit for cell-mode MPLS). The label is used to encode the class to which a packet belongs and the MPLS EXP field (or the CLP bit for cell-mode MPLS) is used to encode the drop precedence of the packet.

LSR --A router that is part of the MPLS network. An LSR forwards a packet based on the value of a label encapsulated in the packet.

label --A short, fixed-length label that tells switching nodes how to forward data (packets). MPLS associates a label with each route. A label associates a network address with the output interface onto which the packet should be transmitted. In the MPLS network, the next-hop IGP (Interior Gateway Protocol) router always advertises to the preceding IGP router (the upstream router) what label should be placed on the packets. The next-hop BGP (Border Gateway Protocol) router always advertises to the preceding BGP router what label should be placed on the packets.

label disposition --The act of removing the last MPLS label from a packet.

label entry --A label entry contains a label value (which includes labels and other information for forwarding the packet) and an MPLS EXP field (which pertains to the QoS of the packet). When there are two label entries, the top label entry is the IGP (Interior Gateway Protocol) label. The bottom label entry is the BGP (Border Gateway Protocol) label.

label imposition --The act of putting MPLS labels onto a packet for transmission on a label switched path (LSP).

layer management --Ability to apply an additional layer of PHB marking to a packet.

MPLS --Multiprotocol Label Switching. Emerging industry standard upon which label switching is based.

MPLS EXP field --In an MPLS entry, the per-hop behavior (PHB) is marked in the MPLS EXP field within the MPLS label entry.

P router --provider core router.

PE router --provider edge router. A router, at the edge of a service provider’s network, that interfaces to CE routers.

penultimate hop popping --Removing a label at the penultimate router. A label is removed and copied to the label that is one lower.

penultimate router --The second-to-last router; that is, the router that is immediately before the egress router.

PHB --per-hop behavior. A unique discard and scheduling behavior that is applied to a packet. The DiffServ treatment (scheduling/dropping) applied by a router to all the packets that are to experience the same DiffServ service.

policing --Limiting the input or output transmission rate of a class of traffic based on user-defined criteria. Policing marks packets by setting the IP precedence value, the qos-group, or the DSCP value.

policy map --Action that is taken if a packet matches what was specified in the class-map. For example, if voice packets were identified and the class-map and voice packets are received, the specified policy map action is taken.

pop --The act of removing a label entry from a packet.

provider network --A backbone network that is under the control of a service provider, and provides transport between customer sites.

push --To put a label entry onto a packet.

QoS --quality of service. Measure of performance for a transmission system that reflects its transmission quality and service availability.

QoS transparency --Method of forwarding packets through a network where the customer's IP marking in the IP packet is preserved.

qos-group --Local variable that indicates the PHB scheduling class (PSC).

rate limiting --See *policing* .

recolor --To change the PHB marking on a packet.

swap --To replace a label entry on a packet.

ToS --type of service. Byte in the IPv4 header.

traffic policy --A traffic policy consists of a traffic class and one or more QoS features. You create a traffic policy by associating the traffic class with one or more QoS features (using the **policy-map** command).

transparency --Preservation of the customer's IP marking in the IP packet.

tunneling --The ability of QoS to be transparent from one edge of a network to the other edge of the network.

VPN --Virtual Private Network. A network that enables IP traffic to use tunneling to travel securely over a public TCP/IP network.

WRED --weighted random early detection. A queuing method that ensures that high-precedence traffic has lower loss rates than other traffic during times of congestion.