



Mark Packets to Change Priority Settings

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Packet Marking Overview

You can use packet marking in input policy maps to set or modify the attributes for traffic belonging to a specific class. For example, you can change the CoS value in a class or set IP DSCP or IP precedence values for a specific type of traffic. These new values are then used to determine how the traffic should be treated.



Note From Cisco IOS XR Release 7.2.12 onwards, support for marking packets on Layer 2 transport interfaces is the same as the support for marking on Layer 3 interfaces. However, this support applies only to the main interface (physical and bundle interfaces), and not on the sub-interfaces.

Default Marking

When an ingress or egress interface adds VLAN tags or MPLS labels, it requires a default value for the class of service and EXP values that go into those tags and labels.

On the router, one ingress default QoS mapping profile and one egress default QoS mapping profile are created and configured per device during initialization.

QoS Behavior for Generic Routing Encapsulation (GRE) Tunnels

Table 1: Feature History Table

Feature Name	Release Information	Feature Description
QoS Behavior for Generic Routing Encapsulation (GRE) Tunnels: Default Marking	Release 7.3.1	With the support for GRE encapsulation and decapsulation tunnel interfaces, there are some important updates to QoS behavior for GRE tunnels. These updates are applicable for default packet marking and involve Type of Service (ToS) and MPLS experimental bits.

GRE Encapsulation

If you do not configure Type of Service (ToS), the outer IP precedence value or the differentiated services code point (DSCP) value is copied from the inner IP header. If you configure ToS, the outer IP precedence value or DSCP value is as per the ToS configuration.

GRE Decapsulation

During decapsulation, the MPLS experimental bits (EXP) are derived from the outer IP packet.

For more information on GRE tunnels, see the *Interfaces Configuration Guide for Cisco 8000 Series Routers, IOS XR Release 7.3.x*.

Packet Marking

The packet marking feature, also called explicit marking, provides users with a means to differentiate packets based on the designated markings. The router supports ingress and egress packet marking.

Supported Packet Marking Operations

This table shows the supported packet marking operations.

Table 2: Supported Packet Marking Operations for Egress and Ingress

Supported Mark Types	Range	Support for Unconditional Marking	Support for Conditional Marking
set discard-class	0-1	ingress	No
set dscp	0-63	ingress, egress	No
set mpls experimental topmost	0-7	ingress, egress	No
set precedence	0-7	ingress, egress	No
set qos-group	0-31	ingress	No

QoS Behavior for Generic Routing Encapsulation (GRE) Tunnels

Table 3: Feature History Table

Feature Name	Release Information	Feature Description
QoS Behavior for Generic Routing Encapsulation (GRE) Tunnels: Explicit Marking	Release 7.3.1	With the support for GRE encapsulation and decapsulation tunnel interfaces, there are some important updates to QoS behavior for GRE tunnels. These updates are applicable for explicit packet marking and involve QoS behavior during ingress and egress.

GRE Encapsulation

During encapsulation of IPv4/IPv6 payload inside the GRE header, QoS behavior is as follows:

- Ingress: QoS supports classification on the payload Layer 3 fields or EXP and remarking payload IP header DSCP.
- Egress: QoS supports setting outer GRE IP header DSCP. It doesn't overwrite the Tunnel Type of Service (ToS) configuration and doesn't remark GRE IP header DCSP.

GRE Decapsulation

During decapsulation of the outer GRE header (during which the inner IPv4/IPv6/MPLS payload is forwarded to the next-hop router), QoS behavior is as follows:

- Ingress: QoS supports classification on Layer 3 fields of outer GRE using the **set qos-group** command. Setting DSCP on the ingress interface sets DSCP for the inner headers.
- Egress: QoS supports classification using **qos-group** to set DSCP or EXP for egress packets.

For more information on GRE tunnels, see the *Interfaces Configuration Guide for Cisco 8000 Series Routers, IOS XR Release 7.3.x*.

Class-based Unconditional Packet Marking Feature and Benefits

The packet marking feature allows you to partition your network into multiple priority levels or classes of service, as follows:

- Use QoS unconditional packet marking to set the IP precedence or IP DSCP values for packets entering the network. Routers within your network can then use the newly marked IP precedence values to determine how the traffic should be treated.

On ingress direction, after matching the traffic based on either the IP Precedence or DSCP value, you can set it to a particular discard-class. Weighted random early detection (WRED), a congestion avoidance technique, thereby uses discard-class values to determine the probability that a packet is dropped.

- Use QoS unconditional packet marking to assign MPLS packets to a QoS group. The router uses the QoS group to determine how to prioritize packets for transmission. To set the QoS group identifier on MPLS packets, use the **set qos-group** command in policy map class configuration mode.



Note Setting the QoS group identifier does not automatically prioritize the packets for transmission. You must first configure an egress policy that uses the QoS group.

- Mark Multiprotocol Label Switching (MPLS) packets by setting the EXP bits within the imposed or topmost label.
- Mark packets by setting the value of the *qos-group* argument.
- Mark packets by setting the value of the *discard-class* argument.



Note *qos-group* and *discard-class* are variables internal to the router, and are not transmitted.

The configuration task is described in the [Configure Class-based Unconditional Packet Marking, on page 4](#).

Configure Class-based Unconditional Packet Marking

This configuration task explains how to configure the following class-based, unconditional packet marking features on your router:

- IP precedence value
- IP DSCP value
- QoS group value (ingress only)
- CoS value (egress only on Layer 3 subinterfaces)
- MPLS experimental value
- Discard class



Note IPv4 and IPv6 QoS actions applied to MPLS tagged packets are not supported. The configuration is accepted, but no action is taken.

Configuration Example

Follow these steps to configure unconditional packet marking features on your router.

1. Create or modify a policy map that can be attached to one or more interfaces to specify a service policy and enter the policy map configuration mode.
2. Configure an interface and enter the interface configuration mode.

3. Attach a policy map to an input or output interface to be used as the service policy for that interface.

Configuration Example

```
router# configure
router(config)# interface hundredGigE 0/0/0/24
router(config-pmap)# policy-map policy1
Router(config-int)# commit
```

Running Configuration

```
router(config)# policy-map policy1

class-map match-any class1
  match protocol ipv4
end-class-map
!
!
policy-map policy1
  class class1
    set precedence 1
  !
  class class-default
  !
end-policy-map
!
interface HundredGigE0/0/0/24
  service-policy input policy1
!
!
```

Verification

Run this command to display policy configuration information for all classes configured for all service policies on the specified interface.

```
router# show run interface hundredGigE 0/0/0/24
```

Mark IP DSCP and MPLS EXP Values for IP to MPLS Traffic

Table 4: Feature History Table

Feature Name	Release Information	Feature Description
Mark IP DSCP and MPLS EXP Values for IP to MPLS Traffic	Release 7.5.4	<p>We've provided you with more granular control for IP to MPLS traffic, so you can collect billing information for your customers upstream at the MPLS core and correlate them with subsequent next-hop IP nodes. This helps you accurately bill your customers as they pay for specific services based on their network requirements.</p> <p>Such control is possible because we've enabled the remarking of IP DSCP values in the inner IP header—that remain even after the POP tag removes the outer header—along with the existing ability to remark MPLS EXP values on the outer MPLS header.</p> <p>There's no action required for you to enable this functionality, and there are no changes to command options.</p>

In earlier releases, when you remarked the DSCP value in the ingress policy for IP to MPLS traffic, here's what happened post the MPLS imposition:

- The inner IP header didn't receive the remarked DSCP value, meaning that the QoS action you required for the IP packet across the network didn't take place.
- The outer header received the remarked value for EXP bits based on your remarking action.

From Cisco IOS XR Release 7.5.4, for IP traffic flowing across an MPLS core, here's the QoS behavior when you remark or set the DSCP value in the ingress policy:

- At the ingress, when the MPLS header is imposed on an IP packet, the inner IP header receives the DSCP value you remarked in the ingress policy. In other words, the IP DSCP value in the inner header is remarked.
- As in earlier releases, the top label in the MPLS header receives the remarked value for EXP bits based on your remarking action. This value for the EXP bits is derived from the three most significant bits of the remarked DSCP value.

Mark IP DSCP and MPLS EXP Values for IP to MPLS Traffic: Benefits

With the ability to remark IP DSCP and MPLS EXP values at the ingress, you have granular control of QoS actions across hops in your network. You can now collect customer-specific billing information upstream at the MPLS core and collate it with the traffic service provided at various IP locations.

Mark IP DSCP and MPLS EXP Values for IP to MPLS Traffic: Guidelines and Limitations

- This functionality is available only on Cisco Silicon One Q200-based fixed and distributed systems.
- You can use a Cisco Silicon One Q100-based line card for distributed systems, but the egress line card must be Cisco Silicon One Q200-based. Else, the feature won't work.

Configure IP DSCP and MPLS EXP Values for IP to MPLS Traffic

Configuration Example

In this example, you set the DSCP value (or assured forwarding per-hop behavior [PHB]) as AF41 for the policy map named **INGRESS_REMARK** at the ingress. At the ingress PE router, the configuration would be:

```
Router(config)#class-map AF31
Router(config-cmap)#match dscp AF31
Router(config-cmap)#end-class-map
Router(config)#
Router(config)#policy-map INGRESS_REMARK
Router(config-pmap)#class AF31
Router(config-pmap-c)#set dscp AF41
Router(config-pmap-c)#end-policy-map
Router(config)#
Router(config)#interface FourHundredGigE0/0/0/0
Router(config-if)#service-policy input INGRESS_REMARK
Router(config-if)#commit
```

At the egress PE router, your configuration would be:

```
Router(config)#class-map AF31
Router(config-cmap)#match dscp AF31
Router(config-cmap)#end-class-map
Router(config)#
Router(config)#class-map AF41
Router(config-cmap)#match dscp AF41
Router#end-class-map
Router(config)#
Router(config)#policy-map INGRESS_CLASSIFY
Router(config-pmap)#class AF31
Router(config-pmap-c)#set traffic-class 3
Router(config-pmap-c)#exit
Router(config-pmap)#
Router(config-pmap)#class AF41
Router(config-pmap-c)#set traffic-class 4
Router(config-pmap-c)#exit
Router(config-pmap)#end-policy-map
```

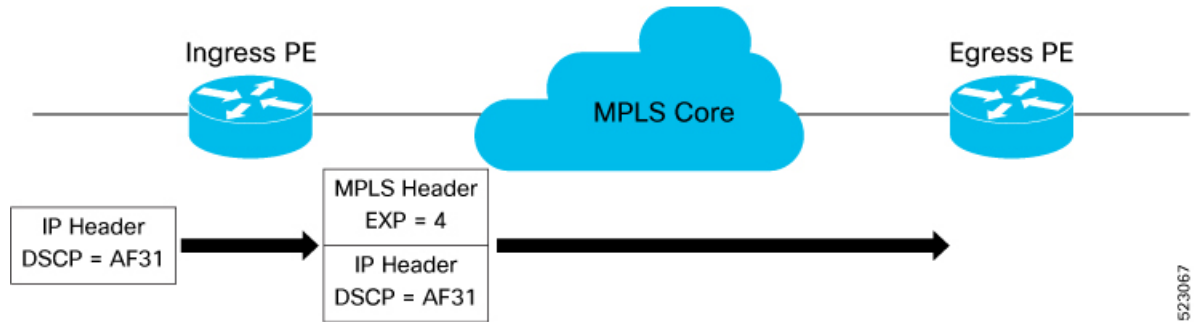
```

Router(config)#
Router(config)#int FourHundredGigE0/0/0/1
Router(config-if)#service-policy input INGRESS_CLASSIFY
Router(config-if)#commit

```

Verification

Figure 1: MPLS QoS Behavior Before Cisco IOS XR Release 7.5.4



Before this release, even though you configured the new DSCP value as AF41 for the policy map named **INGRESS_REMARK** at the ingress, the output for the **show policy-map interface** showed that the assured forwarding marking wasn't applied for the PHB. Thus, the statistics counter displayed zero for Class AF41 at the egress PE router.

```
Router#show policy-map interface FourHundredGigE0/0/0/1 input
```

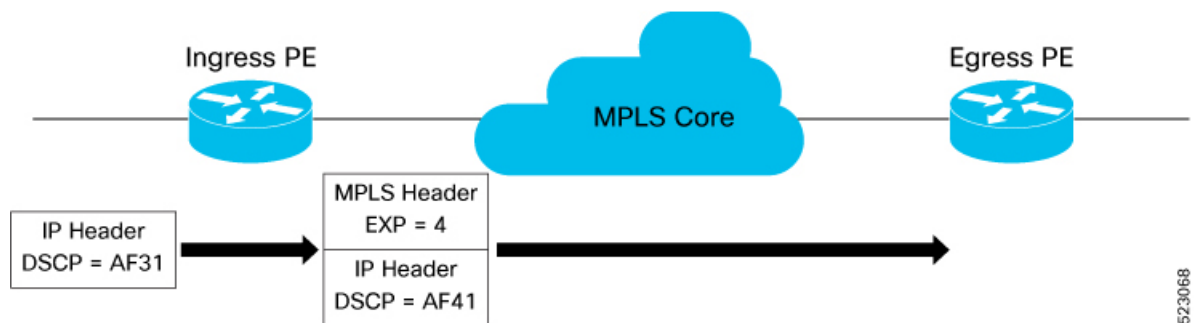
```
FourHundredGigE0/0/0/1 input: INGRESS_CLASSIFY
```

```

Class AF31
  Classification statistics      (packets/bytes)      (rate - kbps)
  Matched                      :      9813350/13738690000      936847
  Transmitted                   :      9813350/13738690000      936847
  Total Dropped                 :                0/0                0
Class AF41
  Classification statistics      (packets/bytes)      (rate - kbps)
  Matched                      :                0/0                0
  Transmitted                   :                0/0                0
  Total Dropped                 :                0/0                0
Class class-default
  Classification statistics      (packets/bytes)      (rate - kbps)
  Matched                      :                0/0                0
  Transmitted                   :                0/0                0
  Total Dropped                 :                0/0                0

```

Figure 2: MPLS QoS Behavior From Cisco IOS XR Release 7.5.4



With the ability to remark IP DSCP values in the inner IP header, the **show policy-map interface** command now displays traffic statistics for Class AF41 at the egress PE router. These statistics confirm that the requisite QoS action—which is, DSCP remark—has taken place at the ingress PE router.

```
Router#show policy-map interface FourHundredGigE0/0/0/1 input

FourHundredGigE0/0/0/1 input: INGRESS_CLASSIFY

Class AF31
  Classification statistics          (packets/bytes)    (rate - kbps)
  Matched                          :                   0/0                0
  Transmitted                       :                   0/0                0
  Total Dropped                     :                   0/0                0
Class AF41
  Classification statistics          (packets/bytes)    (rate - kbps)
  Matched                          :          9813350/13738690000    936847
  Transmitted                       :          9813350/13738690000    936847
  Total Dropped                     :                   0/0                0
Class class-default
  Classification statistics          (packets/bytes)    (rate - kbps)
  Matched                          :                   0/0                0
  Transmitted                       :                   0/0                0
  Total Dropped                     :                   0/0                0
```

Class-based Unconditional Packet Marking: Examples

These are typical examples for class-based unconditional packet marking.

IP Precedence Marking Configuration: Example

In this example, a service policy called *policy1* is created. This service policy is associated to a previously defined class map called *class1* through the use of the **class** command, and then the service policy is attached to the output HundredGigE interface 0/7/0/1. The IP precedence bit in the ToS byte is set to 1:

```
policy-map policy1
  class class1
    set precedence 1
!
interface HundredGigE 0/7/0/1
  service-policy output policy1
```

IP DSCP Marking Configuration: Example

In this example, a service policy called *policy1* is created. This service policy is associated to a previously defined class map through the use of the **class** command. In this example, it is assumed that a class map called *class1* was previously configured and new class map called *class2* is created.

In this example, the IP DSCP value in the ToS byte is set to 5:

```
policy-map policy1
  class class1
    set dscp 5
```

```
class class2
  set dscp ef
```

After you configure the settings shown for voice packets at the edge, all intermediate routers are configured to provide low-latency treatment to the voice packets, as follows:

```
class-map voice
  match dscp ef
policy-map qos-policy
  class voice
    priority level 1
    police rate percent 10
```

QoS Group Marking Configuration: Example

In this example, a service policy called *policy1* is created. This service policy is associated to a class map called *class1* through the use of the **class** command, and then the service policy is attached in the input direction on a HundredGigE 0/7/0/1. The qos-group value is set to 1.

```
class-map match-any class1
  match protocol ipv4
  match access-group ipv4 101

policy-map policy1
  class class1
    set qos-group 1
  !
interface HundredGigE 0/7/0/1
  service-policy input policy1
```



Note The **set qos-group** command is supported only on an ingress policy.

CoS Marking Configuration: Example

In this example, a service policy called *policy1* is created. This service policy is associated to a class map called *class1* through the use of the **class** command, and then the service policy is attached in the output direction on a HundredGigE 0/7/0/1.100. The IEEE 802.1p (CoS) bits in the Layer 2 header are set to 1.

```
class-map match-any class1
  match protocol ipv4
  match access-group ipv4 101

policy-map policy1
  class class1
    set cos 1
  !

interface HundredGigE 0/7/0/1.100
  service-policy input policy1
```

MPLS Experimental Bit Imposition Marking Configuration: Example

In this example, a service policy called *policy1* is created. This service policy is associated to a class map called *class1* through the use of the **class** command, and then the service policy is attached in the input direction on a HundredGigE 0/7/0/1. The MPLS EXP bits of all imposed labels are set to 1.

```
class-map match-any class1
  match protocol ipv4
  match access-group ipv4 101

policy-map policy1
  class class1
    set mpls exp imposition 1
  !
interface HundredGigE 0/7/0/1
  service-policy input policy1
```



Note The **set mpls exp imposition** command is supported only on an ingress policy.

MPLS Experimental Topmost Marking Configuration: Example

In this example, a service policy called *policy1* is created. This service policy is associated to a class map called *class1* through the use of the **class** command, and then the service policy is attached in the output direction on a HundredGigE 0/7/0/1. The MPLS EXP bits on the TOPMOST label are set to 1:

```
class-map match-any class1
  match mpls exp topmost 2

policy-map policy1
  class class1
    set mpls exp topmost 1
  !
interface HundredGigE 0/7/0/1
  service-policy output policy1
```

Queuing and Marking Policies: Examples

These examples explain how queuing and marking can be applied to an interface.

Ingress Traffic Classification and QoS Mapping Configuration for Input Interfaces

In this example, a policy map named "INGRESS_L3" is configured, specifically for classifying and marking incoming traffic.

```
RP/0/RP0/CPU0:Router#show policy-map pmap-name INGRESS_L3 detail

class-map match-all CONTROL_PLANE
match dscp cs7
end-class-map
!
class-map match-all VOIP
match dscp cs6
end-class-map
```

```

!
class-map match-all VIDEO_STREAM
match dscp cs5
end-class-map
!
class-map match-all TRANSACTIONAL_DATA
match dscp cs4
end-class-map
!
class-map match-all DB_SYNC
match dscp cs3
end-class-map
!
class-map match-all BULK_DATA
match dscp cs2
end-class-map
!
class-map match-all SCAVENGER
match dscp cs1
end-class-map
!
policy-map INGRESS_L3
class CONTROL_PLANE
set traffic-class 7
set qos-group 27
!
class VOIP
set traffic-class 6
set qos-group 26
!
class VIDEO_STREAM
set traffic-class 5
set qos-group 25
!
class TRANSACTIONAL_DATA
set traffic-class 4
set qos-group 24
!
class DB_SYNC
set traffic-class 3
set qos-group 23
!
class BULK_DATA
set traffic-class 2
set qos-group 22
!
class SCAVENGER
set traffic-class 1
set qos-group 21
!
class class-default
!
end-policy-map
!

```

Egress Queueing Policy Configuration

In this example, a policy map named "EGRESS_QOS_QUEUEING" is configured for the egress (outgoing) direction.

```
RP/0/RP0/CPU0:Router#show policy-map pmap-name EGRESS_QOS_QUEUEING detail
```

```
class-map match-any TC7_CONTROL_PLANE
match traffic-class 7
```

```

    end-class-map
    !
    class-map match-any TC6_VOIP
    match traffic-class 6
    end-class-map
    !
    class-map match-any TC5_VIDEO_STREAM
    match traffic-class 5
    end-class-map
    !
    class-map match-any TC4_TRANSACTIONAL_DATA
    match traffic-class 4
    end-class-map
    !
    class-map match-any TC3_DB_SYNC
    match traffic-class 3
    end-class-map
    !
    class-map match-any TC2_BULK_DATA
    match traffic-class 2
    end-class-map
    !
    class-map match-any TC1_SCAVENGER
    match traffic-class 1
    end-class-map
    !
    policy-map EGRESS_QOS_QUEUEING
    class TC7_CONTROL_PLANE
    priority level 1
    !
    class TC6_VOIP
    priority level 2
    !
    class TC5_VIDEO_STREAM
    bandwidth remaining ratio 20
    random-detect 50 mbytes 100 mbytes
    !
    class TC4_TRANSACTIONAL_DATA
    bandwidth remaining ratio 20
    queue-limit 75 mbytes
    !
    class TC3_DB_SYNC
    bandwidth remaining ratio 10
    !
    class TC2_BULK_DATA
    bandwidth remaining ratio 10
    !
    class TC1_SCAVENGER
    bandwidth remaining ratio 5
    !
    class class-default
    !
    end-policy-map
    !

```

Egress Marking Policy Configuration

In this example, a policy map named "EGRESS_REMARK" is configured for the egress (outgoing) direction.

```
RP/0/RP0/CPU0:Router#show policy-map pmap-name EGRESS_REMARK detail
```

```

class-map match-any QG4
match qos-group 4
end-class-map

```

```

!
class-map match-any QG3
match qos-group 3
end-class-map
!
class-map match-any QG2
match qos-group 2
end-class-map
!
policy-map EGRESS_REMARK
class QG4
set dscp af42
!
class QG3
set dscp af33
!
class QG2
set dscp af21
!
class class-default
!
end-policy-map
!

```

Output Interface Configuration with Queuing Policy and Remark Policy Applied

```

interface FourHundredGigE0/2/0/29
mtu 10000
service-policy output EGRESS_REMARK
service-policy output EGRESS_QOS_QUEUEING
ipv4 address 18.29.0.1 255.255.255.0
ipv6 address 18:1d::1/96
!

```

IP Precedence Compared to IP DSCP Marking

If you need to mark packets in your network and all your devices support IP DSCP marking, use the IP DSCP marking to mark your packets because the IP DSCP markings provide more unconditional packet marking options. If marking by IP DSCP is undesirable, however, or if you are unsure if the devices in your network support IP DSCP values, use the IP precedence value to mark your packets. The IP precedence value is likely to be supported by all devices in the network.

You can set up to 8 different IP precedence markings and 64 different IP DSCP markings.

Configure DSCP CS7 (Precedence 7)

See the following example to configure options in DSCP for a particular source address in IPv4 packets.

Configuration Example

```

policy-map policy1
class class1
set dscp cs7
!

```

In-Place Policy Modification

The In-Place policy modification feature allows you to modify a QoS policy even when the QoS policy is attached to one or more interfaces. A modified policy is subjected to the same checks that a new policy is subject to when it is bound to an interface. If the policy-modification is successful, the modified policy takes effect on all the interfaces to which the policy is attached. However, if the policy modification fails on any one of the interfaces, an automatic rollback is initiated to ensure that the pre-modification policy is in effect on all the interfaces.

You can also modify any class map used in the policy map. The changes made to the class map take effect on all the interfaces to which the policy is attached.



Note

- The QoS statistics for the policy that is attached to an interface are lost (reset to 0) when the policy is modified.
 - When a QoS policy attached to an interface is modified, there might not be any policy in effect on the interfaces in which the modified policy is used for a short period of time.
 - An in-place modification of an ACL does not reset the policy-map statistics counter.
-

Verification

If unrecoverable errors occur during in-place policy modification, the policy is put into an inconsistent state on target interfaces. No new configuration is possible until the configuration session is unblocked. It is recommended to remove the policy from the interface, check the modified policy and then re-apply accordingly.

Recommendations for Using In-Place Policy Modification

For a short period of time while a QoS policy is being modified, there might not be any policy in effect on the interfaces in which the modified policy is used. For this reason, modify QoS policies that affect the fewest number of interfaces at a time. Use the **show policy-map targets** command to identify the number of interfaces that will be affected during policy map modification.

