QoS: Classification Configuration Guide, Cisco IOS XE 17 (Cisco ASR 920 Series)

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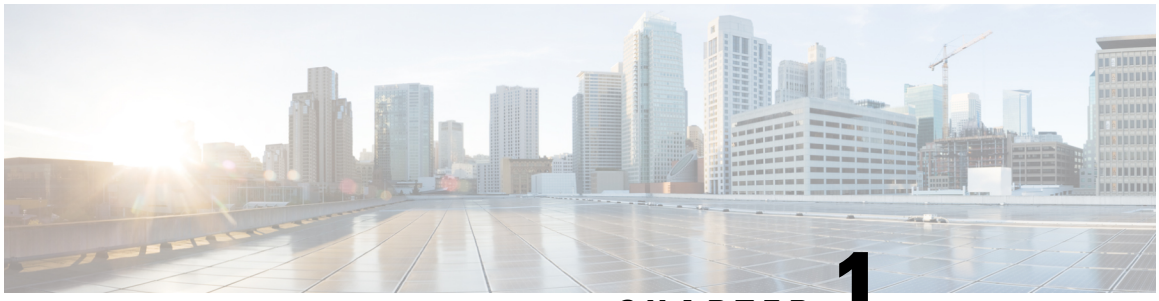


CHAPTER 1

Marking Network Traffic

Marking network traffic allows you to set or modify the attributes for traffic (that is, packets) belonging to a specific class or category. When used in conjunction with network traffic classification, marking network traffic is the foundation for enabling many quality of service (QoS) features on your network. This module contains conceptual information and the configuration tasks for marking network traffic.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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

Prerequisites for Marking Network Traffic

In order to mark network traffic, Cisco Express Forwarding must be configured on both the interface receiving the traffic and the interface sending the traffic.

Restrictions for Marking Network Traffic

- Cos Marking is not supported for pop 0.

- You cannot configure QoS with empty class map and cannot attach a policy without any class map match condition.
- When fragment offset is set in the IP header, the system does not classify it as a L4 (TCP) header. The IP header is not subjected to the class-map that matches on the TCP or port combination. Hence, the traffic uses the class-default option.
- When a fragment offset is set in the IP reader, the network processor will not resolve the L4 header. Hence, the default L4 source or L4 destination port is assumed as '0'.

For information, see Quality of Service Configuration Guidelines (Cisco ASR 920 Series)

Information About Marking Network Traffic

Purpose of Marking Network Traffic

Traffic marking is a method used to identify certain traffic types for unique handling, effectively partitioning network traffic into different categories.

After the network traffic is organized into classes by traffic classification, traffic marking allows you to mark (that is, set or change) a value (attribute) for the traffic belonging to a specific class. For instance, you may want to change the class of service (CoS) value from 2 to 1 in one class, or you may want to change the differentiated services code point (DSCP) value from 3 to 2 in another class. In this module, these values are referred to as attributes.

Attributes that can be set and modified include the following:

- Discard-class value
- DSCP value in the type of service (ToS) byte
- MPLS EXP field value in the topmost label on an input interface
- Multiprotocol Label Switching (MPLS) experimental (EXP) field on all imposed label entries
- Precedence value in the packet header
- QoS group identifier (ID)
- ToS bits in the header of an IP packet

For information on attributes that marking supports see, Quality of Service Configuration Guidelines for Cisco NCS 4200 Series.

For information on attributes that marking supports see, Quality of Service Configuration Guidelines for Cisco ASR 920 Series.

Benefits of Marking Network Traffic

Table 1: Feature History

Feature Name	Release	Description
DSCP Preservation of MLDP Traffic	Cisco IOS XE Amsterdam 17.1.1	The Differentiated Services Code Point (DSCP) value does not change on both the uniform and pipe modes.

Improved Network Performance

Traffic marking allows you to fine-tune the attributes for traffic on your network. This increased granularity helps single out traffic that requires special handling and, thus, helps to achieve optimal application performance.

Traffic marking allows you to determine how traffic will be treated, based on how the attributes for the network traffic are set. It allows you to segment network traffic into multiple priority levels or classes of service based on those attributes, as follows:

- The DSCP field (TAG to IP) value does not change in both the uniform mode and in pipe mode. This is applicable to both the Unicast and Multicast traffic scenario.
- Traffic marking is often used to set the IP precedence or IP DSCP values for traffic entering a network. Networking devices within your network can then use the newly marked IP precedence values to determine how traffic should be treated. For example, voice traffic can be marked with a particular IP precedence or DSCP, and a queueing mechanism can then be configured to put all packets of that mark into a priority queue.
- Traffic marking can be used to identify traffic for any class-based QoS feature (any feature available in policy-map class configuration mode, although some restrictions exist).
- Traffic marking can be used to assign traffic to a QoS group within a device. The device can use the QoS groups to determine how to prioritize traffic for transmission. The QoS group value is used for one of the two following reasons:
  - To leverage a large range of traffic classes. The QoS group value has 100 different individual markings, as opposed to DSCP and IP precedence, which have 64 and 8, respectively.

Note The QoS group range is 0–7 on the Cisco RSP3 Module.

  - If changing the IP precedence or DSCP value is undesirable.

- If a packet (for instance, in a traffic flow) that needs to be marked to differentiate user-defined QoS services is leaving a device and entering a switch, the device can set the CoS value of the traffic, because the switch can process the Layer 2 CoS header marking. Alternatively, the Layer 2 CoS value of the traffic leaving a switch can be mapped to the Layer 3 IP or MPLS value.

Note The mapping of Layer 2 CoS value of the traffic to the Layer 3 IP or MPLS value is *not* supported on the Cisco RSP3 Module.

- Weighted random early detection (WRED) uses precedence values or DSCP values to determine the probability that the traffic will be dropped. Therefore, the Precedence and DSCP can be used along with WRED.

Two Methods for Marking Traffic Attributes

There are two methods for specifying and marking traffic attributes:

- You can specify and mark the traffic attribute by using a **set** command.

  With this method, you configure individual **set** commands for the traffic attribute that you want to mark.

- You can specify and mark the traffic attribute by creating a mapping table (called a "table map").

  With this method, you configure the traffic attributes that you want to mark once in a table map and then the markings can be propagated throughout the network.

  These methods are further described in the sections that follow.

Mark Traffic Attributes Using a set Command

You specify the traffic attribute that you want to change with a **set**command configured in a policy map. The table below lists the available **set**commands and the corresponding attribute. The table also includes the network layer and the network protocol typically associated with the traffic attribute.

Table 2: set Commands and Corresponding Traffic Attribute, Network Layer, and Protocol

set Commands[1]	Traffic Attribute	Network Layer	Protocol
set cos	Layer 2 CoS value of the outgoing traffic	Layer 2	
set discard-class	discard-class value	Layer 2	
set dscp	DSCP value in the ToS byte	Layer 3	IP
set mpls experimental imposition	MPLS EXP field on all imposed label entries	Layer 3	MPLS
set mpls experimental topmost	MPLS EXP field value in the topmost label on either an input or an output interface	Layer 3	MPLS
set precedence	Precedence value in the packet header	Layer 3	IP
set qos-group	QoS group ID	Layer 3	IP, MPLS

[1] Cisco set commands can vary by release. For more information, see the command documentation for the Cisco release that you are using

Note The **set qos-group** can be used for L2 traffic on the Cisco ASR 900 RSP3 Module.

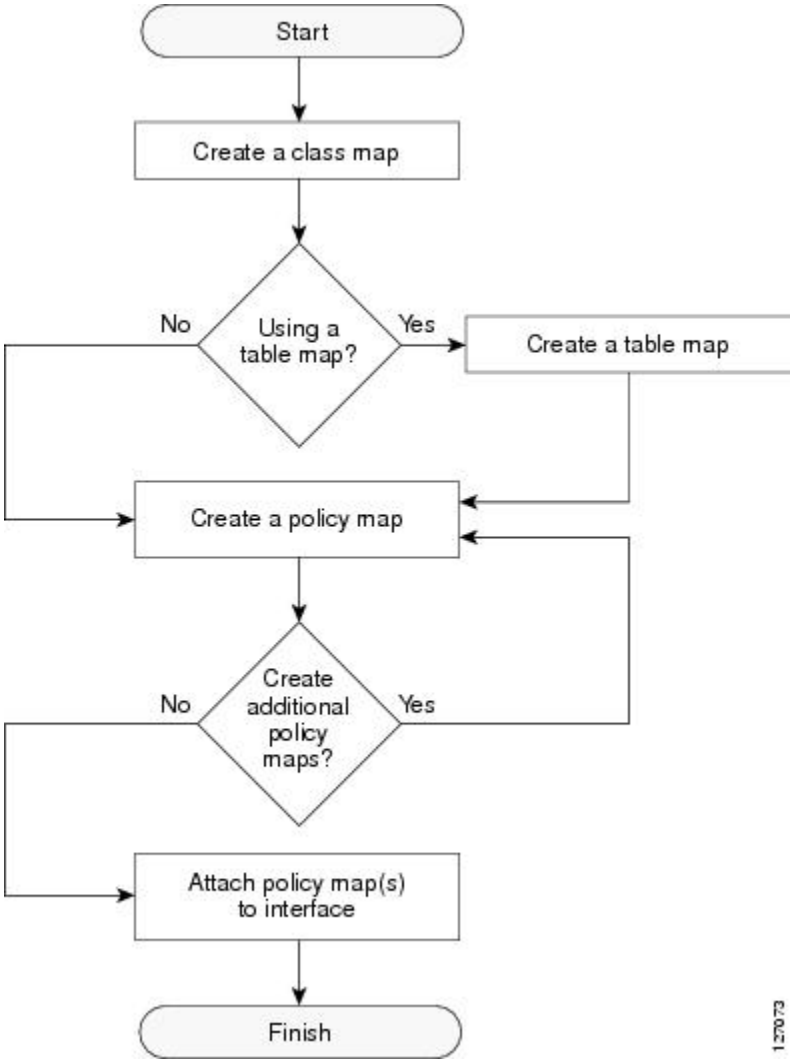
```
policy-map policy1
```

```
class class1
 set dscp 1
 end
```

Traffic Marking Procedure Flowchart

The figure below illustrates the order of the procedures for configuring traffic marking.

Figure 1: Traffic Marking Procedure Flowchart



MQC and Network Traffic Marking

To configure network traffic marking, you use the Modular QoS CLI (MQC).

The MQC is a CLI structure that allows you to complete the following tasks:

- Specify the matching criteria used to define a traffic class.

- Create a traffic policy (policy map). The traffic policy defines the QoS policy actions to be taken for each traffic class.
- Apply the policy actions specified in the policy map to an interface, EFP, Trunk EFP, or Xconect by using the **service-policy** command.

Traffic Classification Compared with Traffic Marking

Traffic classification and traffic marking are closely related and can be used together. Traffic marking can be viewed as an additional action, specified in a policy map, to be taken on a traffic class.

Traffic classification allows you to organize into traffic classes on the basis of whether the traffic matches specific criteria. For example, all traffic with a CoS value of 2 is grouped into one class, and traffic with a DSCP value of 3 is grouped into another class. The match criteria are user-defined.

After the traffic is organized into traffic classes, traffic marking allows you to mark (that is, set or change) an attribute for the traffic belonging to that specific class. For instance, you may want to change the CoS value from 2 to 1, or you may want to change the DSCP value from 3 to 2.

The match criteria used by traffic classification are specified by configuring a **match** command in a class map. The marking action taken by traffic marking is specified by configuring a **set** command in a policy map. These class maps and policy maps are configured using the MQC.

The table below compares the features of traffic classification and traffic marking.

Table 3: Traffic Classification Compared with Traffic Marking

Feature	Traffic Classification	Traffic Marking
Goal	Groups network traffic into specific traffic classes on the basis of whether the traffic matches the user-defined criterion.	After the network traffic is grouped into traffic classes, modifies the attributes for the traffic in a particular traffic class.
Configuration Mechanism	Uses class maps and policy maps in the MQC.	Uses class maps and policy maps in the MQC.
CLI	In a class map, uses **match** commands (for example, **match cos**) to define the traffic matching criteria.	Uses the traffic classes and matching criteria specified by traffic classification. In addition, uses **set** commands (for example, **set cos**) in a policy map to modify the attributes for the network traffic.

Table Maps

You can use table maps to manage a large number of traffic flows with a single command. Table-maps are supported only as part of a mark-down policer. Table maps are used only in input policy maps.

Table maps can be used to:

- Correlate specific CoS, DSCP, or IP precedence values to specific CoS, DSCP, or IP precedence values
- Mark down a CoS, DSCP, or IP precedence value

- Assign defaults for unmapped values

A table map includes one of these default actions:

- **default** *default-value*—applies a specific default value (0 to 63) for all unmapped values
- **default copy**—maps all unmapped values to the equivalent value in another qualifier
- **default ignore**—makes no changes for unmapped values

This example creates a table to map specific CoS values to DSCP values. The default command maps all unmapped CoS values to a DSCP value of 63.

```
Router(config)# table-map cos-dscp-tablemap
 Router(config-tablemap)# map from 5 to 46
 Router(config-tablemap)# map from 6 to 56
 Router(config-tablemap)# map from 7 to 57
 Router(config-tablemap)# default 63
 Router(config-tablemap)# exit
```

The router supports a maximum of 256 unique table maps. You can enter up to 64 different map from-to entries in a table map. These table maps are supported on the router:

- CoS to Precedence
- CoS to DSCP
- CoS to CoS
- CoS to EXP
- CoS to QoS-Group
- CoS to Discard-Class
- Precedence to CoS
- Precedence to DSCP
- Precedence to Precedence
- Precedence to EXP
- Precedence to QoS-Group
- Precedence to Discard-Class
- DSCP to Precedence
- DSCP to CoS
- DSCP to DSCP
- DSCP to EXP
- DSCP to QoS-Group
- DSCP to Discard-Class

Tunneling Cases (Layer 2 VPN or Layer 3 VPN):

- EXP to Precedence
- EXP to CoS
- EXP to DSCP
- EXP to EXP
- EXP to QoS-Group
- EXP to Discard-Class

Table-maps are only supported as part of a policer action, that is, **conform-action**, **exceed-action** or **violate-action** command in a police function.

Table maps are not supported in output policy maps. For more information, see the Configuring Table Maps, on page 12 section.

How to Mark Network Traffic

Creating a Class Map for Marking Network Traffic

Step 1 **enable**

Example:

```
Router> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **configure terminal**

Example:

```
Router# configure terminal
```

Enters global configuration mode.

Step 3 **class-map** *class-map-name* [**match-all**| **match-any**]

Example:

```
Router(config)# class-map class1
```

Creates a class map to be used for matching traffic to a specified class, and enters class-map configuration mode.

- Enter the class map name.

Step 4 **match cos** *cos-value*

Example:

```
Router (config)# match cos 1
```

Matches with Cos value.

cos-value: Sets the Cos Value. The valid values are 1 and 2.

Step 5 **end**

Example:

```
Router(config-cmap)# end
```

(Optional) Returns to privileged EXEC mode.

Creating a Policy Map for Applying a QoS Feature to Network Traffic

Before you begin

The following restrictions apply to creating a QoS policy map:

- A policy map containing the **set qos-group** command can only be attached as an input traffic policy. QoS group values are not usable for traffic leaving a device.
- A policy map containing the set cos command cannot be attached as an output traffic policy.

Step 1 **enable**

Example:

```
Device> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **configure terminal**

Example:

```
Device# configure terminal
```

Enters global configuration mode.

Step 3 **policy-map** *policy-map-name*

Example:

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

Specifies the name of the policy map and enters policy-map configuration mode.

Step 4 **class** {*class-name* | **class-default**}

Example:

```
Device(config-pmap)# class class1
```

Specifies the name of the class whose policy you want to create and enters policy-map class configuration mode. This class is associated with the class map created earlier.

Step 5 **set cos** *cos-value*

Example:

```
Device(config-pmap-c)# set cos 2
```

(Optional) Sets the CoS value in the type of service (ToS) byte.

Note The **set cos** command is an example of one of the **set** commands that can be used when marking traffic. Other **set** commands can be used. For a list of other **set** commands, see "Information About Marking Network Traffic".

Step 6 **end**

Example:

```
Device(config-pmap-c)# end
```

Returns to privileged EXEC mode.

Step 7 **show policy-map**

Example:

```
Device# show policy-map
```

(Optional) Displays all configured policy maps.

Step 8 **show policy-map** *policy-map* **class** *class-name*

Example:

```
Device# show policy-map policy1 class class1
```

(Optional) Displays the configuration for the specified class of the specified policy map.

What to Do Next

Create and configure as many policy maps as you need for your network. To create and configure additional policy maps, repeat the steps in the "Creating a Policy Map for Applying a QoS Feature to Network Traffic" section. Then attach the policy maps to the appropriate interface, following the instructions in the "Attaching the Policy Map to an Interface" section.

Attaching the Policy Map to an Interface, EFP or Xconnect

Before you begin

Note Depending on the needs of your network, policy maps can be attached to targets that are supported. For information, see *Quality of Service Configuration Guidelines (Cisco ASR 920 Series)*.

Step 1 **configure terminal**

Enter global configuration mode.

Example:

```
Router# configure terminal
```

Step 2 **interface** *interface-id*

Specify the port to attach to the policy map, and enter interface configuration mode. Valid interfaces are physical ports.

Example:

```
Router(config)# interface gigabitethernet 0/3/6
```

Step 3 **service instance** *number* **ethernet** [*name*]

Configure an EFP (service instance) and enter service instance configuration) mode.

- The number is the EFP identifier, an integer from 1 to 4000.
- (Optional) **ethernet** name is the name of a previously configured EVC. You do not need to use an EVC name in a service instance.

Example:

```
Rotuer(config)# service instance 1 ethernet
```

Step 4 **service-policy** {**input** | **output**} *policy-map-name*

Attaches the specified policy map to the input or output interfaces .

- *policy-map-name*: Specifies the policy map.

Example:

```
Router(config-if-srv)# service-policy input co1
```

Step 5 **encapsulation** {**default** | **dot1q** | **priority-tagged** | **untagged**}

Configure encapsulation type for the service instance.

- **default**—Configure to match all unmatched packets.
- **dot1q**—Configure 802.1Q encapsulation. See *Table 1* for details about options for this keyword.
- **priority-tagged**—Specify priority-tagged frames, VLAN-ID 0 and CoS value of 0 to 7.
- **untagged**—Map to untagged VLANs. Only one EFP per port can have untagged encapsulation.

Example:

```
Router(config-if-srv)# encapsulation dot1q 1
```

Step 6 **bridge-domain** *bridge-id* [**split-horizon group** *group-id*]

Configure the bridge domain ID. The range is from 1 to 4000.

You can use the **split-horizon** keyword to configure the port as a member of a split horizon group. The *group-id* range is from 0 to 2.

Example:

```
Router(config-if-srv)# bridge-domain 1
```

Step 7 **end**

Return to privileged EXEC mode.

Example:

```
Router(config-if-srv)# end
```

Configuration Example

```
Router(config)# interface gigabitethernet 0/3/6
Router(config-if)# service instance 1 ethernet
Router(config-if-srv)# service-policy input co1
Router(config-if-srv)# encapsulation dot1q 1
Router(config-if-srv)# bridge-domain 1
Router(config-if-srv)# end
```

Configuring Table Maps

Note these guidelines when configuring table maps:

- The router supports a maximum of 256 unique table maps.
- The maximum number of map statements within a table map is 64.
- Table maps cannot be marked using **set** commands. To mark table map, configure policer with 100% CIR.
- Table map marking cannot be done at interface or VLAN level.
- Multiple **set** table map marking transformations cannot be used for the same class. To mark table map, configure policer with 100% CIR.
- Ingress marking with and without table-map simultaneously under the same class cannot be done.
- Table maps cannot be used in output policy maps.
- Dynamic modification of the table map definition is not supported. To make changes to the table map, remove the table map from the policy map, make any necessary changes to the table map and then reconfigure it in the policy map.
- Dynamic addition, deletion or modification of the table-map to or from class-default in a physical level policy (pure class-default policy without other user-defined classes) is not supported.
- Dynamic addition, deletion or modification of policer containing table-map action in class-default in a class-level policy (policy-map that contains user-defined classes along with class-default) is not supported.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **table-map** *table-map-name*

4. **map from** *from-value* **to** *to-value*
5. **default** {*default-value* | **copy** | **ignore**}
6. **end**
7. **show table-map** [*table-map-name*]
8. **copy running-config startup-config**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**table-map** *table-map-name* **Example:** `Router(config)# table-map dscp-to-cos`	Create a table map by entering a table-map name and entering table-map configuration mode.
Step 4	**map from** *from-value* **to** *to-value* **Example:** `Router(config-tablemap)# map from 1 to 1`	Enters the mapping values to be included in the table. For example, if the table map is a DSCP-to-CoS table map, the from-value would be the DSCP value and the to_value would be the CoS value. Both ranges are from 0 to 63. Enter this command multiple times to include all the values that you want to map.
Step 5	**default** {*default-value*	**copy**	**ignore**} **Example:** `Router(config-tablemap)# default 4`	Sets the default behavior for a value not found in the table map. • Enter a *default-value* to specify a certain value. For example, in a DSCP-to-CoS table map, this would be a specific CoS value to apply to all unmapped DSCP values. The range is from 0 to 63. • Enter **copy** to map unmapped values to an equivalent value. In a DSCP-to-CoS table map, this command maps all unmapped DSCP values to the equivalent CoS value. • Enter **ignore** to leave unmapped values unchanged. In a DSCP-to-CoS table map, the switch does not change the CoS value of unmapped DSCP values.
Step 6	**end** **Example:**	(Optional) Returns to privileged EXEC mode.

	Command or Action	Purpose
	`Router(config-tablemap)# end`	
Step 7	**show table-map** [*table-map-name*] **Example:** `Router(config)# show table-map dscp-to-cos`	Verifies your entries.
Step 8	**copy running-config startup-config** **Example:** `Router(config)# copy running-config startup-config`	(Optional) Saves your entries in the configuration file. To delete a table map, use the **no table-map** *table-map-name* global configuration command.

Using a Table Map under a Policy Map

The following procedure uses a table map configured to map CoS to DSCP.

Before you begin

Table map must be configured. To configure a table map, see Configuring Table Maps, on page 12.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **policy-map** *policy-map-name*
4. **class** {*class-name* | **class-default**}
5. **police** {*rate-bps* | **cir** {*cir-bps* | **percent** *percent*}} [**bc** *burst-bytes*] [**conform-action** *action*] [**pir** *pir-bps*] [**be** *be-bps*]
6. **conform-action** *action*
7. **exceed-action** *action*
8. **violate-action** *action*
9. **end**
10. **show policy-map** *policy-map*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:**	Enters global configuration mode.

	Command or Action	Purpose
	`Device# configure terminal`	
Step 3	**policy-map** *policy-map-name* **Example:** `Device(config)# policy-map ingress`	Specifies the name of the policy map and enters policy-map configuration mode.
Step 4	**class** {*class-name* | **class-default**} **Example:** `Device(config-pmap)# class cos 1`	Specifies the name of the class whose policy you want to create and enters policy-map class configuration mode. This class is associated with the class map created earlier.
Step 5	**police** {*rate-bps* | **cir** {*cir-bps* | **percent** *percent*}} [**bc** *burst-bytes*] [**conform-action** *action*] [**pir** *pir-bps*] [**be** *be-bps*] **Example:** `Device(config-pmap-c)# police cir 1000000 bc 31250 pir 2000000 be 62500`	Configure a traffic policer based on the traffic rate or committed information rate (CIR). By default, no policer is defined. • *rate-bps*—Specifies average traffic rate in bits per second (b/s). The range is 64000 to 10000000000. Supply an optional postfix (K, M, G). Decimal point is allowed. • **cir**—Specifies a committed information rate (CIR). • *cir-bps*—Specifies a CIR in bits per second (b/s). The range is 64000 to 10000000000. Supply an optional postfix (K, M, G). Decimal point is allowed. • **bc** *burst-bytes*—(Optional) Specifies the conformed burst (bc) or the number of acceptable burst bytes. The range is 8000 to 16000000. • **conform-action** *action*— (Optional) Specifies action to take on packets that conform to the specified rate limit. • **pir** *pir-bps*—(Optional) Specifies the peak information rate (PIR). • **be** *be-bps*—(Optional) Specifies how much the **pir** can be exceeded, either as a bit rate or an amount of time at **pir**. **Note** You must specify a value for **pir** before the device displays this argument. **Note** **cir percent** *percent* option is not supported on the router.

	Command or Action	Purpose
Step 6	**conform-action** *action* **Example:** `Device(config-pmap-c-police)# conform-action set-cos-transmit dscp table cos-dscp`	Specifies the action to take on packets that conform to the police rate limit and enters policy-map class police configuration mode.
Step 7	**exceed-action** *action* **Example:** `Device(config-pmap-c-police)# exceed-action transmit`	Specifies action to take on packets that exceed the rate limit.
Step 8	**violate-action** *action* **Example:** `Device(config-pmap-c-police)# violate-action drop`	(Optional) Specifies action to take on packets that violate the normal and maximum burst sizes.
Step 9	**end** **Example:** `Device(config-pmap-c)# end`	Returns to privileged EXEC mode.
Step 10	**show policy-map** *policy-map* **Example:** `Device# show policy-map ingress`	(Optional) Displays the configuration for the specified class of the specified policy map.

Configuration Examples for Marking Network Traffic

Example: Creating a Class Map for Marking Network Traffic

- The following is an example of configures a class map with using match-any .

```
Router> enable
Router# configure terminal
Router(config)# interface gigabitethernet0/3/6
Router(config-if)# service instance 1 ethernet
Router(config-if-srv)# encapsulation dot1q 1
Router(config-if-srv)# bridge-domain 1
Device(config)# class-map match-any class1
Device(config-cmap)# match cos 1
Device(config-cmap)# end
```

- The following is an example of configures a class map with using match-all .

```
Router> enable
Router# configure terminal
Router(config)# interface gigabitethernet0/3/6
Router(config-if)# service instance 1 ethernet
Router(config-if-srv)# encapsulation dot1q 1
```

```
Router(config-if-srv)# bridge-domain 1
Device(config)# class-map match-all class1
Device(config-cmap)# match cos 1
Device(config-cmap)# end
```

Example Creating a Policy Map for Applying a QoS Feature to Network Traffic

The following is an example of creating a policy map to be used for traffic classification.

```
Router> enable
Router# configure terminal
Router(config)# policy-map policy1
Router(config-pmap)# class class1
Router(config-pmap-c)# set cos 2
Router(config-pmap-c)# end
Router# exit
```

Example: Attaching a Traffic Policy to an Interface

The following example shows how to attach an existing traffic policy to an interface. After you define a traffic policy with the **policy-map** command, you can attach it to one or more interfaces by using the **service-policy** command in interface configuration mode. Although you can assign the same traffic policy to multiple interfaces, each interface can have only one traffic policy attached in the input direction and only one traffic policy attached in the output direction.

```
Router(config)# interface gigabitethernet0/3/6
Router(config-if)# service instance 1 ethernet
Router(config-if-srv)# service-policy input co1
Router(config-if-srv)# encapsulation dot1q 1
Router(config-if-srv)# bridge-domain 1
Router(config-if)# service-policy input policy1
Router(config-if)# end
```

Additional References for Marking Network Traffic

Related Documents

Related Topic	Document Title
QoS commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	*Cisco IOS Quality of Service Solutions Command Reference*
MQC	"Applying QoS Features Using the MQC" module
Classifying network traffic	"Classifying Network Traffic" module

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

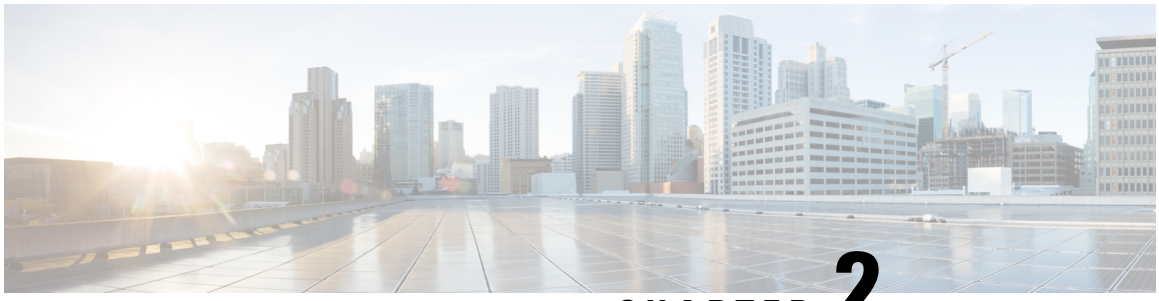
Feature Information for Marking Network Traffic

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 4: Feature Information for Marking Network Traffic

Feature Name	Releases	Feature Information
Table Maps	Cisco IOS XE Release 3.14.0S	This feature was introduced on the Cisco ASR 920 Series Aggregation Services Router (ASR-920-12CZ-A, ASR-920-12CZ-D, ASR-920-4SZ-A, ASR-920-4SZ-D, ASR-920-10SZ-PD, ASR-920-24SZ-IM, ASR-920-24SZ-M, ASR-920-24TZ-M) .
Marking Network Traffic	Cisco IOS XE Release 3.13.0S	This feature was introduced on the Cisco ASR 920 Series Aggregation Services Router (ASR-920-12CZ-A, ASR-920-12CZ-D, ASR-920-4SZ-A, ASR-920-4SZ-D).



CHAPTER 2

Configuration to drop DEI / CFI traffic

If Drop Eligible Indicator (DEI) bit is enabled in 802.1ad header or has Canonical Format Identifier (CFI) bit enabled in 802.1q header on an arriving packet, such packets will be dropped using QOS.

Restriction

Use **platform acl drop-dei-1-packets** command to filter DOT1Q and DOT1AD packets marked with CFI/DEI bits. The feature only matches the outermost tag and the matching on the inner tag is not supported.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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CLI commands used to configure DEI/ CFI traffic behavior

To configure, you need to modify the behavior of the DEI traffic using the CLI commands:

To enable the behavior, use the following CLI command:

platform acl drop-dei-1-packets

To disable the behavior, use the following CLI command:

no platform acl drop-dei-1-packets

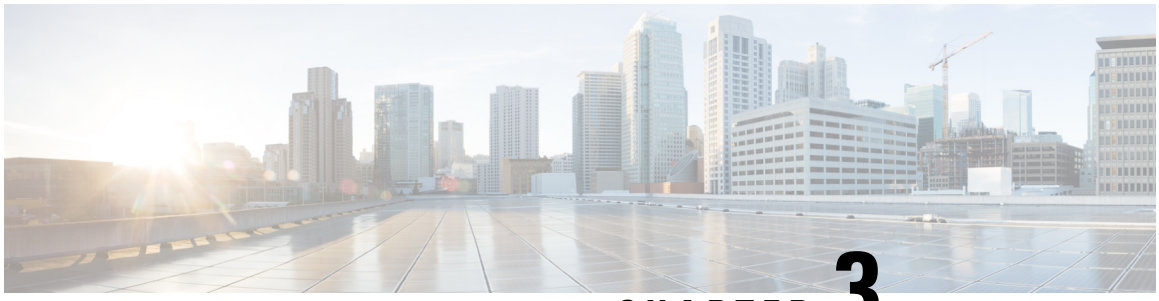
Verifying the DEI/CFI traffic configuration

Use the following commands to verify the DEI/CFI traffic configuration:

show platform hardware pp active tcam utilization qos detail 0

```
Device# show platform hardware pp active tcam utilization qos detail 0
```

This displays TCAM usage of 8 extra entries when command enabled.



CHAPTER 3

Classifying and Marking MPLS EXP

The QoS EXP Matching feature allows you to classify and mark network traffic by modifying the Multiprotocol Label Switching (MPLS) experimental bits (EXP) field in IP packets. This module contains conceptual information and the configuration tasks for classifying and marking network traffic using the MPLS EXP field.

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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Prerequisites for Classifying and Marking MPLS EXP

- The router must be configured as an MPLS provider edge (PE) or provider (P) router, which can include the configuration of a valid label protocol and underlying IP routing protocols.

Restrictions for Classifying and Marking MPLS EXP

- MPLS classification and marking can only occur in an operational MPLS Network.

- MPLS EXP classification and marking is supported on the main router interfaces for MPLS packet switching and imposition (simple IP imposition and Ethernet over MPLS (EoMPLS) imposition) and on Ethernet virtual circuits (EVCs) or Ethernet flow points (EFPs) for EoMPLS imposition.
- MPLS EXP classification or marking for bridged MPLS packets on EVCs or EFPs is not supported.
- MPLS EXP marking is supported only in the ingress direction.
- If a packet is classified by IP type of service (ToS) or class of service (CoS) at ingress, it cannot be reclassified by MPLS EXP at egress (imposition case). However, if a packet is classified by MPLS at ingress it can be reclassified by IP ToS, CoS, or Quality of Service (QoS) group at egress (disposition case).
- If a packet is encapsulated in MPLS, the MPLS payload cannot be checked for other protocols such as IP for classification or marking. Only MPLS EXP marking affects packets encapsulated by MPLS.

Information About Classifying and Marking MPLS EXP

Classifying and Marking MPLS EXP Overview

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

- Classify traffic

  The classification process selects the traffic to be marked. Classification accomplishes this by partitioning traffic into multiple priority levels, or classes of service. Traffic classification is the primary component of class-based QoS provisioning. For more information, see the “Classifying Network Traffic” module.

- Police and mark traffic

  Policing causes traffic that exceeds the configured rate to be discarded or marked to a different drop level. Marking traffic is a way to identify packet flows to differentiate them. Packet marking allows you to partition your network into multiple priority levels or classes of service. For more information, see the “Marking Network Traffic” module.

MPLS Experimental Field

The MPLS experimental bits (EXP) field is a 3-bit field in the MPLS header that you can use to define the QoS treatment (per-hop behavior) that a node should give to a packet. In an IP network, the DiffServ Code Point (DSCP) (a 6-bit field) defines a class and drop precedence. The EXP bits can be used to carry some of the information encoded in the IP DSCP and can also be used to encode the dropping precedence.

By default, Cisco IOS Software copies the three most significant bits of the DSCP or the IP precedence of the IP packet to the EXP field in the MPLS header. This action happens when the MPLS header is initially imposed on the IP packet. However, you can also set the EXP field by defining a mapping between the DSCP or IP precedence and the EXP bits. This mapping is configured using the **set mpls experimental** or **police** commands. For more information, see the “How to Classify and Mark MPLS EXP” section.

Benefits of MPLS EXP Classification and Marking

If a service provider does not want to modify the value of the IP precedence field in packets transported through the network, they can use the MPLS EXP field value to classify and mark IP packets.

By choosing different values for the MPLS EXP field, you can mark critical packets so that those packets have priority if network congestion occurs.

How to Classify and Mark MPLS EXP

Classifying MPLS Encapsulated Packets

Note MPLS EXP topmost classification is not supported for bridged MPLS packets on Ethernet virtual circuits (EVC) or Ethernet flow points (EFP).

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **class-map** [**match-all** | **match-any**] *class-map-name*
4. **match mpls experimental topmost** *mpls-exp-value*
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**class-map** [**match-all**	**match-any**] *class-map-name* **Example:** `Router(config)# class-map exp3`	Creates a class map to be used for matching traffic to a specified class, and enters class-map configuration mode. • Enter the class map name.
Step 4	**match mpls experimental topmost** *mpls-exp-value* **Example:**	Specifies the match criteria.

	Command or Action	Purpose
	`Router(config-cmap)# match mpls experimental topmost 3`	**Note** The **match mpls experimental topmost** command classifies traffic on the basis of the EXP value in the topmost label header.
Step 5	**end** **Example:** `Router(config-cmap)# end`	(Optional) Returns to privileged EXEC mode.

Marking MPLS EXP on All Imposed Labels

Perform this task to set the value of the MPLS EXP field on all imposed label entries.

Before you begin

The router supports MPLS EXP marking only in the ingress direction.

In typical configurations, marking MPLS packets at imposition is used with ingress classification on IP ToS or CoS fields. However, generic matching with the class default value is supported with other ingress attributes such as **vlan**.

Note For IP imposition marking, the IP precedence value is copied to the MPLS EXP value by default.

Note For EVC configuration, a policy map that performs matching based on the CoS and that sets the EXP imposition value should be used to copy CoS values to the EXP value.

Note The **set mpls experimental imposition** command works only on packets that have new or additional MPLS labels added to them.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **policy-map** *policy-map-name*
4. **class** *class-map-name*
5. **set mpls experimental imposition** *mpls-exp-value*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**policy-map** *policy-map-name* **Example:** `Router(config)# policy-map mark-up-exp-2`	Specifies the name of the policy map to be created and enters policy-map configuration mode. • Enter the policy map name.
Step 4	**class** *class-map-name* **Example:** `Router(config-pmap)# class prec012`	Creates a class map to be used for matching traffic to a specified class, and enters class-map configuration mode. • Enter the class map name.
Step 5	**set mpls experimental imposition** *mpls-exp-value* **Example:** `Router(config-pmap-c)# set mpls experimental imposition 2`	Sets the value of the MPLS EXP field on all imposed label entries.
Step 6	**end** **Example:** `Router(config-pmap-c)# end`	(Optional) Returns to privileged EXEC mode.

Marking MPLS EXP on Label Switched Packets

Perform this task to set the MPLS EXP field on label switched packets.

Before you begin

Note The **set mpls experimental topmost** command works only on packets that are already MPLS encapsulated.

Note The router supports MPLS EXP marking in the ingress direction only, and does not support MPLS EXP classification or marking for bridged MPLS packets on EVCs or EFPs.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **policy-map** *policy-map-name*
4. **class** *class-map-name*
5. **set mpls experimental topmost** *mpls-exp-value*
6. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**policy-map** *policy-map-name* **Example:** `Router(config)# policy-map mark-up-exp-2`	Specifies the name of the policy map to be created and enters policy-map configuration mode. • Enter the policy map name.
Step 4	**class** *class-map-name* **Example:** `Router(config-pmap)# class-map exp012`	Creates a class map to be used for matching traffic to a specified class, and enters class-map configuration mode. • Enter the class map name.
Step 5	**set mpls experimental topmost** *mpls-exp-value* **Example:** `Router(config-pmap-c)# set mpls experimental topmost 2`	Sets the MPLS EXP field value in the topmost label on the output interface.
Step 6	**end** **Example:** `Router(config-pmap-c)# end`	(Optional) Returns to privileged EXEC mode.

Configuring Conditional Marking

To conditionally set the value of the MPLS EXP field on all imposed label, perform the following task:

Before you begin

Note The **set-mpls-exp-topmost-transmit** action affects MPLS encapsulated packets only. The **set-mpls-exp-imposition-transmit** action affects any new labels that are added to the packet.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **policy-map** *policy-map-name*
4. **class** *class-map-name*
5. **police cir** *bps* **bc pir** *bps* **be**
6. **conform-action** [**set-mpls-exp-imposition-transmit** *mpls-exp-value* | **set-mpls-exp-topmost-transmit** *mpls-exp-value*]
7. **exceed-action** [**set-mpls-exp-imposition-transmit** *mpls-exp-value* | **set-mpls-exp-topmost-transmit** *mpls-exp-value*]
8. **violate-action drop**
9. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**policy-map** *policy-map-name* **Example:** `Router(config)# policy-map ip2tag`	Specifies the name of the policy map to be created and enters policy-map configuration mode. • Enter the policy map name.
Step 4	**class** *class-map-name* **Example:** `Router(config-pmap)# class iptcp`	Creates a class map to be used for matching traffic to a specified class, and enters policy-map class configuration mode. • Enter the class map name.
Step 5	**police cir** *bps* **bc pir** *bps* **be** **Example:**	Defines a policer for classified traffic and enters policy-map class police configuration mode.

	Command or Action	Purpose
	`Router(config-pmap-c)# police cir 1000000 pir 2000000`	
Step 6	**conform-action** [**set-mpls-exp-imposition-transmit** *mpls-exp-value* | **set-mpls-exp-topmost-transmit** *mpls-exp-value*] **Example:** `Router(config-pmap-c-police)# conform-action set-mpls-exp-imposition-transmit 3`	Defines the action to take on packets that conform to the values specified by the policer. • In this example, if the packet conforms to the committed information rate (cir) or is within the conform burst (bc) size, the MPLS EXP field is set to 3.
Step 7	**exceed-action** [**set-mpls-exp-imposition-transmit** *mpls-exp-value* | **set-mpls-exp-topmost-transmit** *mpls-exp-value*] **Example:** `Router(config-pmap-c-police)# exceed-action set-mpls-exp-imposition-transmit 2`	Defines the action to take on packets that exceed the values specified by the policer. • In this example, if the packet exceeds the cir rate and the bc size, but is within the peak burst (be) size, the MPLS EXP field is set to 2.
Step 8	**violate-action drop** **Example:** `Router(config-pmap-c-police)# violate-action drop`	Defines the action to take on packets whose rate exceeds the peak information rate (pir) and is outside the bc and be ranges. • You must specify the exceed action before you specify the violate action. • In this example, if the packet rate exceeds the pir rate and is outside the bc and be ranges, the packet is dropped.
Step 9	**end** **Example:** `Router(config-pmap-c-police)# end`	(Optional) Returns to privileged EXEC mode.

Configuration Examples for Classifying and Marking MPLS EXP

Example: Classifying MPLS Encapsulated Packets

Defining an MPLS EXP Class Map

The following example defines a class map named exp3 that matches packets that contains MPLS experimental value 3:

```
Router(config)# class-map exp3
Router(config-cmap)# match mpls experimental topmost 3
Router(config-cmap)# exit
```

Defining a Policy Map and Applying the Policy Map to an Ingress Interface

The following example uses the class map created in the example above to define a policy map. This example also applies the policy map to a physical interface for ingress traffic.

```
Router(config)# policy-map change-exp-3-to-2
Router(config-pmap)# class exp3
Router(config-pmap-c)# set mpls experimental topmost 2
Router(config-pmap)# exit
Router(config)# interface GigabitEthernet 0/0/0
Router(config-if)# service-policy input change-exp-3-to-2
Router(config-if)# exit
```

Defining a Policy Map and Applying the Policy Map to an Egress Interface

The following example uses the class map created in the example above to define a policy map. This example also applies the policy map to a physical interface for egress traffic.

```
Router(config)# policy-map WAN-out
Router(config-pmap)# class exp3
Router(config-pmap-c)# shape average 10000000
Router(config-pmap-c)# exit
Router(config-pmap)# exit
Router(config)# interface GigabitEthernet 0/0/0
Router(config-if)# service-policy output WAN-out
Router(config-if)# exit
```

Example: Marking MPLS EXP on All Imposed Labels

Defining an MPLS EXP Imposition Policy Map

The following example defines a policy map that sets the MPLS EXP imposition value to 2 based on the IP precedence value of the forwarded packet:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# class-map prec012
Router(config-cmap)# match ip prec 0 1 2
Router(config-cmap)# exit
Router(config)# policy-map mark-up-exp-2
Router(config-pmap)# class prec012
Router(config-pmap-c)# set mpls experimental imposition 2
Router(config-pmap-c)# exit
Router(config-pmap)# exit
```

Applying the MPLS EXP Imposition Policy Map to a Main Interface

The following example applies a policy map to Gigabit Ethernet interface 0/0/0:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface GigabitEthernet 0/0/0
Router(config-if)# service-policy input mark-up-exp-2
Router(config-if)# exit
```

Applying the MPLS EXP Imposition Policy Map to an EVC

The following example applies a policy map to the Ethernet Virtual Connection specified by the **service instance** command:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface GigabitEthernet 0/0/0
Router(config-inf)# service instance 100 ethernet
Router(config-if-srv)# xconnect 100.0.0.1 encapsulation mpls 100
Router(config-if-srv)# service-policy input mark-up-exp-2
Router(config-if-srv)# exit
Router(config-if)# exit
```

Example: Marking MPLS EXP on Label Switched Packets

Defining an MPLS EXP Label Switched Packets Policy Map

The following example defines a policy map that sets the MPLS EXP topmost value to 2 according to the MPLS EXP value of the forwarded packet:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# class-map exp012
Router(config-cmap)# match mpls experimental topmost 0 1 2
Router(config-cmap)# exit
Router(config-cmap)# policy-map mark-up-exp-2
Router(config-pmap)# class exp012
Router(config-pmap-c)# set mpls experimental topmost 2
Router(config-pmap-c)# exit
Router(config-pmap)# exit
```

Applying the MPLS EXP Label Switched Packets Policy Map to a Main Interface

The following example shows how to apply the policy map to a main interface:

```
Router# configure terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Router(config)# interface GigabitEthernet 0/0/0
Router(config-if)# service-policy input mark-up-exp-2
Router(config-if)# exit
```

Example: Configuring Conditional Marking

The example in this section creates a policer for the **iptcp** class, which is part of the **ip2tag** policy map, and attaches the policy map to the Gigabit Ethernet interface.

```
Router(config)# policy-map ip2tag
Router(config-pmap)# class iptcp
Router(config-pmap-c)# police cir 1000000 pir 2000000
Router(config-pmap-c-police)# conform-action set-mpls-exp-imposition-transmit 3
Router(config-pmap-c-police)# exceed-action set-mpls-exp-imposition-transmit 2
```

```
Router(config-pmap-c-police)# violate-action drop
Router(config-pmap-c-police)# exit
Router(config-pmap-c)# exit
Router(config-pmap)# exit
Router(config)# interface GigabitEthernet 0/0/1
Router(config-if)# service-policy input ip2tag
```

Additional References

Related Documents

Related Topic	Document Title
QoS commands	*Cisco IOS Quality of Service Solutions Command Reference*
Classifying network traffic	"Classifying Network Traffic" module
Marking network traffic	"Marking Network Traffic" module

Standards and RFCs

Standard/RFC	Title
No new or modified standards are supported, and support for existing standards has not been modified.	

MIBs

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

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for Classifying and Marking MPLS EXP

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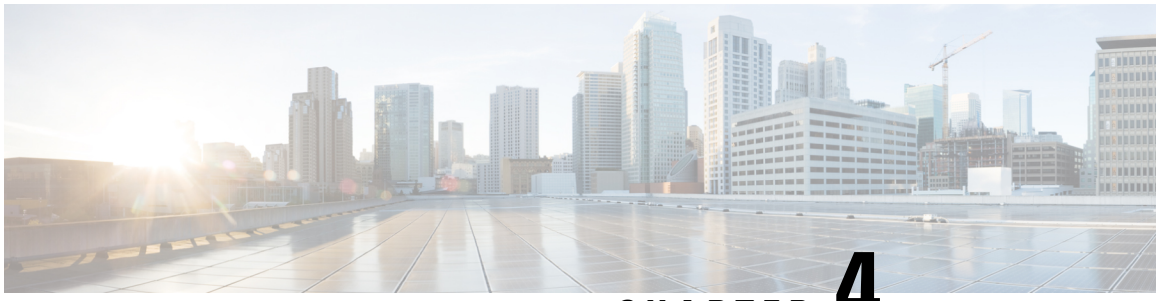
Table 5: Feature Information for Classifying and Marking MPLS EXP

Feature Name	Releases	Feature Information
Classifying and Marking MPLS EXP	Cisco IOS XE Release 3.13.0S	This feature was introduced on the Cisco ASR 920 Series Aggregation Services Router (ASR-920-12CZ-A, ASR-920-12CZ-D, ASR-920-4SZ-A, ASR-920-4SZ-D).



CHAPTER 4

Configuration of an IPv6 Access Control List

IPv6 Access Control Lists (ACLs) determine what traffic is blocked and what traffic is forwarded at device interfaces. ACLs allow filtering based on source and destination addresses, inbound and outbound to a specific interface.

Restrictions

The following restrictions apply when configuring IPv6 ACLs:

- ACE-specific counters are not supported.
- ICMP match is not supported on IPv6 ACL.
- Layer 3 IPv4 and IPv6 ACLs are not supported on same EVC.
- MAC ACLs are not supported on EFP or trunk EFP interfaces to which Layer 3 IPv4 or IPv6 ACLs are applied.
- Up to 500 ACEs per ACL or 1500 total ACEs are supported.
- Egress v4/v6 ACL on EVC is not supported.

The following ACE parameters are supported:

- Source address
- Destination address
- TCP ports
- UDP ports
- DSCP value
- ICMP

Other ACE parameters are not supported.

Configuring IPv6 Access Control List

The sections below describe how to configure an IPv6 ACL on the Cisco ASR 903 Series Router:

Before you begin

Creating an IPv6 Access List

Before you begin

SUMMARY STEPS

1. **configure terminal**
2. **ipv6 access-list** *access-list-name*
3. **permit** *protocol* {*source-ipv6-prefix/prefix-length* | any | host *source-ipv6-address*} [port-number] {*destination-ipv6-prefix/prefix-length* | any | host *destination-ipv6-address*} [*port-number*] [dscp *value*] [log] [log-input] [sequence *value*]
4. **deny** *protocol* {*source-ipv6-prefix/prefix-length* | any | host *source-ipv6-address*} [port-number] {*destination-ipv6-prefix/prefix-length* | any | host *destination-ipv6-address*} [*port-number*] [dscp *value*] [log] [log-input] [sequence *value*]
5. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**ipv6 access-list** *access-list-name* **Example:** `Device(config)# ipv6 access-list ipv6-acl`	Defines an IPv6 ACL, and enters IPv6 access list configuration mode.

Step 3	**permit** *protocol* {*source-ipv6-prefix/prefix-length* | any | host *source-ipv6-address*} [port-number] {*destination-ipv6-prefix/prefix-length* | any | host *destination-ipv6-address*} [*port-number*] [dscp *value*] [log] [log-input] [sequence *value*]
	Example:
	`Device(config-ipv6-acl)# permit`
	`0-255 An IPv6 protocol number`
	`X:X:X:X::X IPv6 source address x:x::y`
	`X:X:X:X::X/0-128 IPv6 source prefix x:x::y/z`
	`ahp Authentication Header Protocol`
	`any Any source prefix`
	`esp Encapsulation Security Payload`
	`hbh Hop by Hop options header`
	`host A single source host`
	`icmp Internet Control Message Protocol`
	`ipv6 Any IPv6`
		Sets permit conditions for the IPv6 ACL.

	Command or Action	Purpose
	pcp Payload Compression Protocol sctp Streams Control Transmission Protocol tcp Transmission Control Protocol udp User Datagram Protocol	
Step 4	**deny** *protocol* {*source-ipv6-prefix/prefix-length* | any | host *source-ipv6-address*} [port-number] {*destination-ipv6-prefix/prefix-length* | any | host *destination-ipv6-address*} [*port-number*] [dscp *value*] [log] [log-input] [sequence *value*] **Example:** Device(config-ipv6-acl)# deny 0-255 An IPv6 protocol number X:X:X:X::X IPv6 source address x:x::y X:X:X:X::X/0-128 IPv6 source prefix x:x::y/z ahp Authentication Header Protocol any Any source prefix esp Encapsulation Security Payload hbh Hop by Hop options header host A single source host icmp Internet Control Message Protocol ipv6 Any IPv6 pcp Payload Compression Protocol sctp Streams Control Transmission Protocol tcp Transmission Control Protocol udp User Datagram Protocol	Sets deny conditions for the IPv6 ACL.
Step 5	**end**	Return to privileged EXEC mode.

Applying an IPv6 Access Control List to a Physical Interface

Before you begin

SUMMARY STEPS

1. **configure terminal**
2. **interface** *interface-id*
3. **ipv6 traffic-filter** *access-list-name [*in | out*]*
4. **end**

DETAILED STEPS

	Command or Action	Purpose
Step 1	**configure terminal**	Enter global configuration mode.
Step 2	**interface** *interface-id*	Specify the port to attach to the policy map, and enter interface configuration mode. Valid interfaces are physical ports.

	Command or Action	Purpose
Step 3	**ipv6 traffic-filter** *access-list-name [*in | out*]* **Example:** `Device(config)# ipv6 traffic-filter ipv6-acl`	Defines an IPv6 ACL, and enters IPv6 access list configuration mode.
Step 4	**end**	Return to privileged EXEC mode.

Example for Configuration of IPv6 ACL

```
Router(config)# ipv6 access-list ipv6_acl
Router(config-ipv6-acl)# permit tcp any any
Router(config-ipv6-acl)# permit udp any any
Router(config-ipv6-acl)# permit any any
Router(config-ipv6-acl)# hardware statistics
Router(config-ipv6-acl)# exit

! Assign an IP address and add the ACL on the interface.

Router(config)# interface GigabitEthernet3/1/0
Router(config-if)# no ip address
Router(config-if)# negotiation auto
Router(config-if)# ipv6 address 2001:1::1/64
Router(config-if)# ipv6 enable
Router(config-if)# ipv6 traffic-filter ipv6_acl in
Router(config-if)# exit
Router(config)# exit
Router# clear counters
Clear "show interface" counters on all interfaces [confirm]
Router#

! Verify the configurations.

Router# show running-config interface GigabitEthernet3/1/0

Building configuration...

Current configuration : 114 bytes
!
interface GigabitEthernet3/1/0
 no ip address
 negotiation auto
 ipv6 address 1001::1/64
 ipv6 traffic-filter ipv6_acl in
end
```

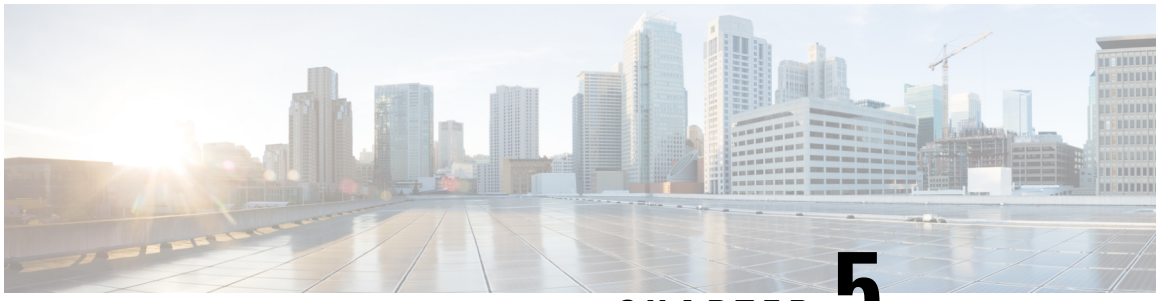
Verifying the Configuration

You can use the following commands to verify your IPv6 ACL configuration on the Cisco ASR 903 Series Router:

- **show platform hardware pp active** acl label *label-number*—Displays ACL information for a given label.

- **show platform hardware pp active** acl name *acl-name*—Displays ACL information for a given ACL name.
- **show platform hardware pp active** acl *acl-name* stats—Displays statistics for a given IPv6 ACL.
- **show platform hardware pp active** tcam utilization acl detail *id*—Displays TCAM usage for a given IPv6 ACL.

Before you begin



CHAPTER 5

IPv6 QoS: MQC Packet Classification

Finding Feature Information

Your software release may not support all the features documented in this module. For the latest caveats and feature information, see Bug Search Tool and the release notes for your platform and software release. To find information about the features documented in this module, and to see a list of the releases in which each feature is supported, see the feature information table.

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

Information About IPv6 QoS: MQC Packet Classification

Implementation Strategy for QoS for IPv6

IPv6 packets are forwarded by paths that are different from those for IPv4. QoS features supported for IPv6 environments include packet classification, queueing, traffic shaping, weighted random early detection (WRED), class-based packet marking, and policing of IPv6 packets. These features are available at both the process switching and Cisco Express Forwarding switching paths of IPv6.

All of the QoS features available for IPv6 environments are managed from the modular QoS command-line interface (MQC). The MQC allows you to define traffic classes, create and configure traffic policies (policy maps), and then attach those traffic policies to interfaces.

To implement QoS in networks running IPv6, follow the same steps that you would follow to implement QoS in networks running only IPv4. At a very high level, the basic steps for implementing QoS are as follows:

- Know which applications in your network need QoS.

- Understand the characteristics of the applications so that you can make decisions about which QoS features would be appropriate.
- Know your network topology so that you know how link layer header sizes are affected by changes and forwarding.
- Create classes based on the criteria you establish for your network. In particular, if the same network is also carrying IPv4 traffic along with IPv6, decide if you want to treat both of them the same way or treat them separately and specify match criteria accordingly. If you want to treat them the same, use match statements such as **match precedence**, **match dscp**. If you want to treat them separately, add match criteria such as **match protocol ip** and **match protocol ipv6** in a match-all class map.
- Create a policy to mark each class.
- Work from the edge toward the core in applying QoS features.
- Build the policy to treat the traffic.
- Apply the policy.

Packet Classification in IPv6

Packet classification is available with both the process and Cisco Express Forwarding switching path. Classification can be based on IPv6 precedence, differentiated services control point (DSCP), and other IPv6 protocol-specific values that can be specified in IPv6 access lists in addition to other non-IPv6 values such as COS, packet length, and QoS group. Once you determine which applications need QoS, you can create classes based on the characteristics of the applications. You can use a variety of match criteria to classify traffic. You can combine various match criteria to segregate, isolate, and differentiate traffic.

The enhancements to the modular QoS CLI (MQC) allow you to create matches on precedence, DSCP, and IPv6 access group values in both IPv4 and IPv6 packets. The **match** command allows matches to be made on DSCP values and precedence for both IPv4 and IPv6 packets.

How to Configure IPv6 QoS: MQC Packet Classification

Classifying Traffic in IPv6 Networks

The **set cos** and **match cos** commands for 802.1Q (dot1Q) interfaces are supported only for packets that are switched by Cisco Express Forwarding. Packets that are process-switched, such as device-generated packets, are not marked when these options are used.

Using Match Criteria to Manage IPv6 Traffic Flows

You can use multiple match statements. Depending on the type of class, you can specify whether to match all classes or any of the classes.

SUMMARY STEPS

1. **enable**
2. **configure terminal**

3. **class-map** {*class-name* | **class-default**}
4. Do one of the following:
   - **match precedence** *precedence-value* [*precedence-value precedence-value*]
   - **match access-group name** *ipv6-access-group*
   - **match [ip] dscp** *dscp-value* [*dscp-value dscp-value dscp-value dscp-value dscp-value dscp-value dscp-value*]

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Device> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Device# configure terminal`	Enters global configuration mode.
Step 3	**class-map** {*class-name* | **class-default**} **Example:** `Device(config-pmap-c)# class-map clsl`	Creates the specified class and enters QoS class-map configuration mode.

Step 4	Do one of the following:
	• **match precedence** *precedence-value* [*precedence-value precedence-value*]
	• **match access-group name** *ipv6-access-group*
	• **match [ip] dscp** *dscp-value* [*dscp-value dscp-value dscp-value dscp-value dscp-value dscp-value dscp-value dscp-value*]
	Example:
	`Device(config-pmap-c)# match precedence 5`
	Example:
	`Device(config-pmap-c)# match ip dscp 15`
		Matches the precedence value. The precedence applies to both IPv4 and IPv6 packets.
		or
		Specifies the name of an IPv6 access list against whose contents packets are checked to determine if they belong to the traffic class.
		or
		Identifies a specific IP DSCP value as a match criterion.

Confirming the Service Policy

Ensure that the traffic flow matches the input or output parameter of the policy. For example, downloading a file from an FTP server generates congestion in the receive direction because the server sends large MTU-sized frames, and the client PC returns small acknowledgments (ACKs).

Before you begin this task, simulate congestion with an extended ping using a large ping size and a large number of pings. Also, try downloading a large file from an FTP server. The file constitutes "disturbing" data and fills the interface bandwidth.

SUMMARY STEPS

1. **enable**
2. **configure terminal**
3. **interface** *type number* **multipoint** | **point-to-point**
4. **ip address ip-address mask** [*secondary*]
5. **pvc** [*name*] *vpi* / *vci* [**ces** | **ilmi** | **qsaal** | **smds**]
6. **tx-ring-limit** *ring-limit*
7. **service-policy** {**input** | **output**} *policy-map-name*

DETAILED STEPS

	Command or Action	Purpose
Step 1	**enable** **Example:** `Router> enable`	Enables privileged EXEC mode. • Enter your password if prompted.
Step 2	**configure terminal** **Example:** `Router# configure terminal`	Enters global configuration mode.
Step 3	**interface** *type number* **multipoint**	**point-to-point** **Example:** `Router(config)# interface gigabitethernet1/1/0 point-to-point`	Enters interface configuration mode.
Step 4	**ip address ip-address mask** [*secondary*] **Example:** `Router(config-if)# ip address 10.1.1.1 255.255.255.0`	Specifies the IP address of the interface you want to test.

Step 5	**pvc** [*name*] *vpi* / *vci* [**ces**	**ilmi**	**qsaal**	**smds**]
				Example:
				`Router(config-if)#`
				`pvc cisco 0/5`
					Creates or assigns a name to an ATM PVC, optionally specifies the encapsulation type on an ATM PVC, and enters interface-ATM-VC configuration mode.

	Command or Action	Purpose
Step 6	**tx-ring-limit** *ring-limit* **Example:** `Router(config-if-atm-vc)# tx-ring-limit 10`	Reduces the size of the transmit ring of the interface. Lowering this value accelerates the use of the QoS in the Cisco IOS software. • Specify the ring limit as the number of packets for 2600 and 3600 series routers, or as the number of memory particles for 7200 and 7500 series routers.
Step 7	**service-policy** {**input** | **output**} *policy-map-name* **Example:** `Router(config-if-atm-vc)# service-policy output policy9`	Attaches a policy map to an input interface or VC, or an output interface or VC, to be used as the service policy for that interface or VC. • The packets-matched counter is a part of queueing feature and is available only on service policies attached in output direction.

Configuration Examples for IPv6 QoS: MQC Packet Classification

Example: Matching DSCP Value

The following example shows how to configure the service policy called priority50 and attach service policy priority50 to an interface. In this example, the **match dscp** command includes the optional **ip** keyword, meaning that the match is for IPv4 packets only. The class map called ipdscp15 will evaluate all packets entering interface GigabitEthernet 1/0/0. If the packet is an IPv4 packet and has a DSCP value of 15, the packet will be treated as priority traffic and will be allocated with bandwidth of 50 kbps.

```
Router(config)#
 class-map ipdscp15
Router(config-cmap)#
 match ip dscp 15
Router(config)#
 exit
Router(config)#
policy-map priority50
Router(config-pmap)#
 class ipdscp15
Router(config-pmap-c)#
priority 50
Router(config-pmap-c)#
exit
Router(config-pmap)#
 exit
Router(config)#
interface gigabitethernet1/0/0
Router(config-if)#
service-policy input priority55
```

To match on IPv6 packets only, use the **match dscp** command without the **ip** keyword preceded by the **match protocol** command. Ensure that the class map has the **match-all** attribute (which is the default).

```
Router(config)#
 class-map ipdscp15
Router(config-cmap)#
 match protocol ipv6
Router(config-cmap)#
 match dscp 15
Router(config)#
 exit
```

To match packets on both IPv4 and IPv6 protocols, use the **match dscp** command:

```
Router(config)#
 class-map ipdscp15
Router(config-cmap)#
 match dscp 15
```

Additional References

Related Documents

Related Topic	Document Title
IPv6 addressing and connectivity	*IPv6 Configuration Guide*
IPv6 commands	*Cisco IOS IPv6 Command Reference*
Cisco IOS IPv6 features	Cisco IOS IPv6 Feature Mapping
Classifying Network Traffic	"Classifying Network Traffic" module

Standards and RFCs

Standard/RFC	Title
RFCs for IPv6	*IPv6 RFCs*

MIBs

MIB	MIBs Link
	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

Technical Assistance

Description	Link
The Cisco Support and Documentation website provides online resources to download documentation, software, and tools. Use these resources to install and configure the software and to troubleshoot and resolve technical issues with Cisco products and technologies. Access to most tools on the Cisco Support and Documentation website requires a Cisco.com user ID and password.	http://www.cisco.com/cisco/web/support/index.html

Feature Information for IPv6 QoS: MQC Packet Classification

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 6: Feature Information for IPv6 QoS: MQC Packet Classification

Feature Name	Releases	Feature Information
IPv6 QoS: MQC Packet Classification	Cisco IOS XE Release 3.13.0S	This feature was introduced on the Cisco ASR 920 Series Aggregation Services Router (ASR-920-12CZ-A, ASR-920-12CZ-D, ASR-920-4SZ-A, ASR-920-4SZ-D).