



Congestion Management Configuration Guide, Cisco IOS XE 16 (Cisco ASR 920 Series)

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CHAPTER 1

Feature History

The following table lists the new and modified features that are supported in the QoS: Congestion Management Configuration Guide in Cisco IOS XE 16 releases.

Feature Name	Cisco IOS XE Release
Support for Seven Level Priority Queues	16.8.1



CHAPTER 2

Multi-Level Priority Queues

The Multi-Level Priority Queues (MPQ) feature allows you to configure multiple priority queues for multiple traffic classes by specifying a different priority level for each of the traffic classes in a single service policy map. You can configure multiple service policy maps per device. Having multiple priority queues enables the device to place delay-sensitive traffic (for example, voice) on the outbound link before delay-insensitive traffic. As a result, high-priority traffic receives the lowest latency possible on the device.

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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 www.cisco.com/go/cfn. An account on Cisco.com is not required.

Prerequisites for Multi-Level Priority Queues

You must configure traffic classes using the **class-map** command.

Restrictions for Multi-Level Priority Queues

- You cannot configure both the **priority** command and the **priority level** command for two different classes in the same policy map. For example, the device does not accept the following configuration:

```
Device> enable
Device# configure terminal
Device(config)# policy-map Map1
Device(config-pmap)# class Bronze
Device(config-pmap-c)# priority level 1
Device(config-pmap-c)# exit
Device(config-pmap)# class Gold
Device(config-pmap-c)# priority 1000
Device(config-pmap-c)# end
```



Note The **priority rate** command is not supported, instead you can use **priority cir** command on the Cisco RSP3 Module.

The following is an example to configure the device on the Cisco RSP3 Module.

```
Device> enable
Device# configure terminal
Device(config)# policy-map Map1
Device(config-pmap)# class Bronze
Device(config-pmap-c)# priority level 1 10000
Device(config-pmap-c)# end
```

- You cannot specify the same priority level for two different classes in the same policy map. For example, the device does not accept the following configuration:

```
Device> enable
Device# configure terminal
Device(config)# policy-map Map1
Device(config-pmap)# class Bronze
Device(config-pmap-c)# priority level 1
Device(config-pmap-c)# police cir percent 30
Device(config-pmap-c)# exit
Device(config-pmap)# class Gold
Device(config-pmap-c)# priority level 1
Device(config-pmap-c)# police cir 10000
Device(config-pmap-c)# end
```

- You cannot configure the default queue as a priority queue at any level.
- You cannot configure the **bandwidth** command and multi-level priority queues on the same class. For example, the device rejects the following configuration:

```
policy-map P1
class C1
priority level 1
bandwidth 200
```

- You cannot configure the **shape** command and multi-level priority queues on the same class. For example, the device rejects the following configuration:


```
policy-map P1
  class C1
    priority level 1
    shape average 56000
```

- To convert a one-level (flat) service policy with multiple priority queues configured to a hierarchical multi-level priority queues service policy, you must first detach the flat service policy from the interface using the **no service-policy** command and then add a child policy map to it.
- The sum of the police committed information rate (cir), which can be specified as in kilobits per second (kbps) or as a percentage, configured at the two priority levels cannot exceed the interface bandwidth. Any policy that has a police cir sum greater than the interface bandwidth will be rejected. For example, the following policy will be rejected by a 1-gigabit (Gb) interface because the sum of the police cir (600 Mb + 700 Mb) is greater than 1 Gb.

```
policy-map new
  class qos-group 1
    priority level 1
    police cir 600000000
  class qos-group 2
    priority level 2
    police cir 700000000
```



Note The **priority** command with **police** command is *not* supported on the Cisco RSP3 Module.

The **priority** command with **shape rate** is supported on the Cisco RSP3 Module to perform the same functionality.

- We recommend not to use MPQ at the logical level, that is, under the class-map containing match for the VLANs .

Information About Multi-Level Priority Queues

Benefits of Multi-Level Priority Queues

The MPQ feature allows you to configure multiple priority queues for multiple traffic classes by specifying a different priority level for each of the traffic classes in a single service policy map. You can configure multiple service policy maps per device.

Previously, devices could have only one strict priority queue per policy map for all delay-sensitive traffic—the device associated all priority traffic with this one single priority queue. However, having only one priority queue can cause significant delay in delivering traffic, especially if the device sends high-priority traffic (for example, voice) behind low-priority traffic (for example, video). Using class-based weighted fair queueing (CBWFQ) to reduce delay by heavily weighting one queue can affect the granularity of bandwidth allocations to the other queues. The MPQ feature addresses these issues and improves latency.

Functionality of Multi-Level Priority Queues

The **priority** command is used to specify that a class of traffic has latency requirements with respect to other classes. For multiple priority queues, you can use the **priority level** command to configure a level of priority service on a class in a policy map. The Cisco RSP1 and RSP3 supports two priority levels: level 1 (high) and level 2 (low) and the Cisco RSP2 supports seven priority levels: level 1 (high) and level 7 (low). The device supports seven priority levels: level 1 (high) to level 7 (low). The device places traffic with a high-priority level on the outbound link ahead of traffic with a low-priority level. High-priority packets, therefore, are not delayed behind low-priority packets.

The device services the high-level priority queues until empty before servicing the next-level priority queues and non-priority queues. While the device services a queue, the service rate is as fast as possible and is constrained only by the rate of the underlying link or parent node in a hierarchy. If a rate is configured and the device determines that a traffic stream has exceeded the configured rate, the device drops the exceeding packets during periods of congestion. If the link is currently not congested, the device places the exceeding packets onto the outbound link.

When configuring MPQ on different traffic classes in a policy map, you must specify different priority levels for the traffic classes. For example, configure one traffic class to have priority level 2 and another class to have priority level 1.



Note In a hierarchical MPQ configuration in which *all* traffic is sent through the level-2 priority queue only, the traffic sent through the level-2 priority queue receives the same treatment as the traffic sent through the level-1 priority queue.

If high-priority traffic is not policed appropriately, bandwidth starvation of low-priority traffic can occur. Therefore, though not required, we recommend that you configure a policer for high-priority traffic using the **police** command. If you configure the **police** command for priority queues, the traffic rate is policed to the police rate for each of the priority queues.



Note The **police** command is *not* applicable on the Cisco RSP3 Module for managing traffic.

You cannot configure the **priority** command and the **priority level** command on different classes in the same policy map.

Traffic Policing and Multi-Level Priority Queues

Bandwidth guarantees can be given to other classes only if traffic policing is enabled on the priority queue.

Using the **priority** and **police** commands, multi-level priority queues can be configured to police traffic in one of the following ways:

- Unconditional traffic policing, for example:

```
policy-map my_policy
  class voice
    priority                <<< Indicates priority scheduling
    police 400000000        <<< Traffic policed to 400M
  class gold
    bandwidth 400000       <<<400M minimum guaranteed to class gold
```

The priority class is configured with an “always on” (unconditional) policer. The priority class is always policed to the configured value regardless of whether the interface is congested. The advantage of an unconditional policer is that you always know how much priority traffic will be offered to the downstream devices, thus making your bandwidth planning much simpler. This is the recommended choice.



Note The following is an example of priority policing on the Cisco ASR 900 RSP3 Module.

```
policy-map my_policy
  class voice
    priority 400000 <<< Indicates priority scheduling and traffic shape rate
  class gold
    bandwidth 400000 <<< Minimum guaranteed to class gold
```

- Absolute priority queue (no traffic policing)

If traffic policing is not configured, the priority traffic may consume the entire interface bandwidth.

How to Configure Multi-Level Priority Queues

Configuring Multi-Level Priority Queues in a Policy Map

Before you begin

The traffic classes, class maps, and policy maps must exist.

Procedure

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-name*

Example:

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

Creates or modifies a policy map and enters policy-map configuration mode.

- Enter the name of the policy map.

Step 4 **class** *class-name*

Example:

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

Specifies a traffic class and enters policy-map class configuration mode.

- Enter the name of a previously configured traffic class.

Step 5 **priority level** *level*

Example:

```
Device(config-pmap-c)# priority level 7
```

Assigns priority to a traffic class at the priority level specified.

- Enter the level of priority assigned to the priority class.

For Cisco RSP1 and RSP3, valid values are 1 (high priority) and 2 (low priority). The default is 1. For Cisco RSP2, valid values are from 1-7.

Valid values are from 1 (high priority) to 7 (lowest priority).

Note Do not specify the same priority level for two different classes in the same policy map.

Step 6 **police cir** *bps*

Example:

```
Device(config-pmap-c)# police cir 8000
```

(Optional) Configures traffic policing based on a bits per second (bps) rate.

- **cir** is the committed information rate and is based on the interface shape rate. This keyword indicates an average rate at which the policer meters traffic.
- *bps* specifies the average rate in bits per second (bps). Valid values are from 64000 to 10000000000 bps.

Step 7 **police cir percent** *percent*

Example:

```
Device(config-pmap-c)# police cir percent 20
```

(Optional) Configures traffic policing based on a percentage of bandwidth available on the interface.

- **cir** is the committed information rate and is based on the interface shape rate. This keyword indicates an average rate at which the policer meters traffic.
- **percent** *percent* indicates to use the percentage of available bandwidth specified in percent to calculate the CIR. Valid values are from 1 to 100.

Step 8 **end****Example:**

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

(Optional) Exits policy-map class mode.

Verifying Multi-Level Priority Queues

Procedure

Step 1 **enable****Example:**

```
Device> enable
```

Enables privileged EXEC mode.

- Enter your password if prompted.

Step 2 **show policy-map interface** *type number***Example:**

```
Device# show policy-map interface serial4/0/0
```

Displays the packet statistics of all classes that are configured for all service policies either on the specified interface or subinterface or on a specific PVC on the interface.

- Enter the interface type and number.

Step 3 **exit****Example:**

```
Device# exit
```

(Optional) Exits privileged EXEC mode.

Configuration Examples for Multi-Level Priority Queues

Example: Configuring Multi-Level Priority Queues

The following example shows how to configure multiple priority queues with 2 level priority. The policy map named Business has two traffic classes: Bronze and Gold. Bronze traffic has a level 2 (low) priority, whereas

Gold traffic has a level 1 (high) priority. To prevent bandwidth starvation of Bronze traffic, the Gold traffic is policed at 30 percent of the interface bandwidth.

```
Device> enable
Device# configure terminal
Device(config)# policy-map Business
Device(config-pmap)# class Bronze
Device(config-pmap-c)# priority level 2
Device(config-pmap-c)# police cir 1000
Device(config-pmap-c)# exit
Device(config-pmap)# class Gold
Device(config-pmap-c)# priority level 1
Device(config-pmap-c)# police cir percent 30
Device(config-pmap-c)# end
```



Note Although a policer is not required, configure policing for priority traffic to prevent bandwidth starvation of low-priority traffic. When policing is configured, the traffic rate is policed at the police rate for each of the priority queues.

The following example shows how to configure multiple priority queues with 7 level priority. The policy map named Business has seven traffic classes: Platinum, Gold, Silver, Bronze, Iron, Aluminium, and Steel. Steel traffic has a level 7 (lowest) priority, whereas Platinum traffic has a level 1 (highest) priority. To prevent bandwidth starvation, the Platinum and Gold traffic is policed at 30 percent and 20 percent respectively, of the interface bandwidth.

```
Device> enable
Device# configure terminal
Device(config)# policy-map Business
Device(config-pmap)# class Platinum
Device(config-pmap-c)# priority level 1
Device(config-pmap-c)# police cir percent 30
Device(config-pmap-c)# end
Device(config-pmap)# class Gold
Device(config-pmap-c)# priority level 2
Device(config-pmap-c)# police cir percent 20
Device(config-pmap-c)# end
Device(config-pmap)# class Silver
Device(config-pmap-c)# priority level 3
Device(config-pmap-c)# police cir 1000
Device(config-pmap-c)# end
Device(config-pmap)# class Bronze
Device(config-pmap-c)# priority level 4
Device(config-pmap-c)# end
Device(config-pmap)# class Iron
Device(config-pmap-c)# priority level 5
Device(config-pmap-c)# end
Device(config-pmap)# class Aluminum
Device(config-pmap-c)# priority level 6
Device(config-pmap-c)# end
Device(config-pmap)# class Steel
Device(config-pmap-c)# priority level 7
Device(config-pmap-c)# end
```

Example: Verifying Multi-Level Priority Queues

The following is partial sample output from the `show policy-map interface` command.

```
Device# show policy-map interface Gigabit/TenGig 2/1/0

Gigabit/TenGig 2/1/0
Service-policy output: P1
Queue statistics for all priority classes:
.
.
.
Class-map: Gold (match-all)
0 packets, 0 bytes    /*Updated for each priority level configured.*/
5 minute offered rate 0 bps, drop rate 0 bps
Match: ip precedence 2
Priority: 0 kbps, burst bytes 1500, b/w exceed drops: 0
Priority Level 2:
0 packets, 0 bytes
```

Priority Propagation

When priority is not configured on any queue, all queues within a sub-channel are treated equally. Priority can be set for any queue within a sub-channel. In that case, the queue is treated according to its priority. However, this priority is not considered when scheduling is done across multiple sub-channels. In other words, the priority defined at the queue level is lost when packets from different sub-channels are scheduled at the egress. Effective Cisco IOS-XE Release 3.15.0S, priority defined at the PHB (queue) level is propagated for scheduling across sub-channel levels.

A channel is the parent stream for the sub-channel, which in turn is the parent for the queue. During priority propagation of a child stream, the parent gets the priority for that child in its own expedite or normal group.



Note At queue-level, scheduling in expedite or normal group works in Strict Priority Mode, whereas at sub-channel level scheduling occurs in a round robin manner.

Restrictions for the Priority Propagation

- Priority Propagation is supported only for per-hop behavior (PHB)-level classes.
- Priority Propagation works only for the sub-channels within same group (expedite/normal).
- Priority levels for queue-level classes across different sub-channels are treated the same when propagated at the sub-channel level.
- A priority propagated queue does not get priority over queues of other sub-channels that are configured as an expedite queue and CIR is configured on them (that is, priority is set on the sub-channel)
- Priority propagated queue with CIR configured on its sub-channel will compete with HPCT queue traffic.

Configuring the Priority Propagation

Procedure

	Command or Action	Purpose
Step 1	enable Example: Router> enable	Enables privileged EXEC mode.
Step 2	configure terminal Example: Router# configure terminal	Enters global configuration mode.
Step 3	policy-map <i>policy-name</i> Example: Router(config)# policy-map foo	Creates or specifies the name of the traffic policy and enters policy-map configuration mode.
Step 4	class {<i>class-name</i> class-default} Example: Router(config-pmap)# class bar	Specifies the name of a traffic class and enters policy-map class configuration mode.
Step 5	priority level <i>level</i> Example: Router(config-pmap-c)# priority level 2	Configures multiple priority queues <i>level</i> —(Optional) Defines multiple levels of a strict priority service model. When you enable a traffic class with a specific level of priority service, the implication is a single priority queue associated with all traffic enabled with the specified level of priority service. Valid values are from 1 (high priority) and 2 (low priority). The default value is 1.

Verifying the Priority Propagation Configuration

```
Router# show policy-map root
Policy Map root
  Class class-default
    Shape average 100Mb
```

```
Router# show policy-map q1
  Class dscp1
    Priority level 2
Router# show policy-map q2
  Class dscp1
```

```
Router# show running-config interface gigabitEthernet 0/4/3
Building configuration...

Current configuration: 408 bytes
```



```

!
interface GigabitEthernet0/4/3
 no ip address
 negotiation auto
 service-policy output root
 service instance 10 ethernet
  encapsulation dot1q 10
  rewrite ingress tag pop 1 symmetric
 service-policy output q1      => vlan 10 dscp 1 gets priority over vlan 100
 dscp 1 traffic
 bridge-domain 10
!
service instance 100 ethernet
 encapsulation dot1q 100
 rewrite ingress tag pop 1 symmetric
 service-policy output q2
 bridge-domain 100
!
end

```

Additional References for Multi-Level Priority Queues

Related Documents

Related Topic	Document Title
QoS commands: complete command syntax, command modes, command history, defaults, usage guidelines, and examples	<i>Cisco IOS Quality of Service Solutions Command Reference</i>
Priority queues, creating classes, class maps, and policy maps	“Applying QoS Features Using the MQC” 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 Multi-Level Priority Queues

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

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

Table 1: Feature Information for Multi-Level Priority Queues

Feature Name	Releases	Feature Information
Multi-Level Priority Queues	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).
Priority Propagation	Cisco IOS XE Release 3.15.0S	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, ASR-920-24SZ-IM, ASR-920-24SZ-M, ASR-920-24TZ-M)