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Junos<sup>®</sup> OS

# Class of Service Configuration Guide for Security Devices

Release  
12.1



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Juniper Networks, Inc.  
1194 North Mathilda Avenue  
Sunnyvale, California 94089  
USA  
408-745-2000  
www.juniper.net

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Release 12.1

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# About This Guide

This preface provides the following guidelines for using the *Junos OS Class of Service Configuration Guide for Security Devices*:

- [J Series and SRX Series Documentation and Release Notes on page xi](#)
- [Objectives on page xii](#)
- [Audience on page xii](#)
- [Supported Routing Platforms on page xii](#)
- [Document Conventions on page xii](#)
- [Documentation Feedback on page xiv](#)
- [Requesting Technical Support on page xiv](#)

## J Series and SRX Series Documentation and Release Notes

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For a list of related J Series documentation, see  
<http://www.juniper.net/techpubs/software/junos-jseries/index-main.html>.

For a list of related SRX Series documentation, see  
<http://www.juniper.net/techpubs/hardware/srx-series-main.html>.

If the information in the latest release notes differs from the information in the documentation, follow the *Junos OS Release Notes*.

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Juniper Networks supports a technical book program to publish books by Juniper Networks engineers and subject matter experts with book publishers around the world. These books go beyond the technical documentation to explore the nuances of network architecture, deployment, and administration using the Junos operating system (Junos OS) and Juniper Networks devices. In addition, the Juniper Networks Technical Library, published in conjunction with O'Reilly Media, explores improving network security, reliability, and availability using Junos OS configuration techniques. All the books are for sale at technical bookstores and book outlets around the world. The current list can be viewed at <http://www.juniper.net/books>.

## Objectives

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This guide describes how to use and configure key security features on J Series Services Routers and SRX Series Services Gateways running Junos OS. It provides conceptual information, suggested workflows, and examples where applicable.

## Audience

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This manual is designed for anyone who installs, sets up, configures, monitors, or administers a J Series Services Router or an SRX Series Services Gateway running Junos OS. The manual is intended for the following audiences:

- Customers with technical knowledge of and experience with networks and network security, the Internet, and Internet routing protocols
- Network administrators who install, configure, and manage Internet routers

## Supported Routing Platforms

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This manual describes features supported on J Series Services Routers and SRX Series Services Gateways running Junos OS.

## Document Conventions

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Table 1 on page xii defines the notice icons used in this guide.

Table 1: Notice Icons





Icon	Meaning	Description
	Informational note	Indicates important features or instructions.
	Caution	Indicates a situation that might result in loss of data or hardware damage.
	Warning	Alerts you to the risk of personal injury or death.
	Laser warning	Alerts you to the risk of personal injury from a laser.

Table 2 on page xiii defines the text and syntax conventions used in this guide.

Table 2: Text and Syntax Conventions

Convention	Description	Examples
<b>Bold text like this</b>	Represents text that you type.	To enter configuration mode, type the <b>configure</b> command:  user@host> <b>configure</b>
Fixed-width text like this	Represents output that appears on the terminal screen.	user@host> <b>show chassis alarms</b>  No alarms currently active
<i>Italic text like this</i>	<ul style="list-style-type: none"> <li>Introduces important new terms.</li> <li>Identifies book names.</li> <li>Identifies RFC and Internet draft titles.</li> </ul>	<ul style="list-style-type: none"> <li>A policy <i>term</i> is a named structure that defines match conditions and actions.</li> <li><i>Junos OS System Basics Configuration Guide</i></li> <li>RFC 1997, <i>BGP Communities Attribute</i></li> </ul>
<i>Italic text like this</i>	Represents variables (options for which you substitute a value) in commands or configuration statements.	Configure the machine's domain name:  [edit] root@# <b>set system domain-name</b> <i>domain-name</i>
Text like this	Represents names of configuration statements, commands, files, and directories; interface names; configuration hierarchy levels; or labels on routing platform components.	<ul style="list-style-type: none"> <li>To configure a stub area, include the <b>stub</b> statement at the [edit protocols ospf area area-id] hierarchy level.</li> <li>The console port is labeled <b>CONSOLE</b>.</li> </ul>
< > (angle brackets)	Enclose optional keywords or variables.	<b>stub</b> <default-metric <i>metric</i> >;
(pipe symbol)	Indicates a choice between the mutually exclusive keywords or variables on either side of the symbol. The set of choices is often enclosed in parentheses for clarity.	<b>broadcast</b>   <b>multicast</b>  ( <i>string1</i>   <i>string2</i>   <i>string3</i> )
# (pound sign)	Indicates a comment specified on the same line as the configuration statement to which it applies.	<b>rsvp { # Required for dynamic MPLS only</b>
[ ] (square brackets)	Enclose a variable for which you can substitute one or more values.	<b>community name members</b> [ <i>community-ids</i> ]
Indentation and braces ( { } )	Identify a level in the configuration hierarchy.	[edit] routing-options { static { route default { nexthop <i>address</i> ; retain; } } }
;(semicolon)	Identifies a leaf statement at a configuration hierarchy level.	

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#### J-Web GUI Conventions

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Table 2: Text and Syntax Conventions (*continued*)

Convention	Description	Examples
<b>Bold text like this</b>	Represents J-Web graphical user interface (GUI) items you click or select.	<ul style="list-style-type: none"> <li>In the Logical Interfaces box, select <b>All Interfaces</b>.</li> <li>To cancel the configuration, click <b>Cancel</b>.</li> </ul>
<b>&gt;</b> (bold right angle bracket)	Separates levels in a hierarchy of J-Web selections.	In the configuration editor hierarchy, select <b>Protocols&gt;Ospf</b> .

## Documentation Feedback

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- Document or topic name
- URL or page number
- Software release version (if applicable)

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- JTAC policies—For a complete understanding of our JTAC procedures and policies, review the JTAC User Guide located at <http://www.juniper.net/us/en/local/pdf/resource-guides/7100059-en.pdf>.
- Product warranties—For product warranty information, visit <http://www.juniper.net/support/warranty/>.
- JTAC Hours of Operation —The JTAC centers have resources available 24 hours a day, 7 days a week, 365 days a year.

## Self-Help Online Tools and Resources

For quick and easy problem resolution, Juniper Networks has designed an online self-service portal called the Customer Support Center (CSC) that provides you with the following features:

- Find CSC offerings: <http://www.juniper.net/customers/support/>
- Find product documentation: <http://www.juniper.net/techpubs/>

- Find solutions and answer questions using our Knowledge Base: <http://kb.juniper.net/>
- Download the latest versions of software and review release notes:  
<http://www.juniper.net/customers/csc/software/>
- Search technical bulletins for relevant hardware and software notifications:  
<https://www.juniper.net/alerts/>
- Join and participate in the Juniper Networks Community Forum:  
<http://www.juniper.net/company/communities/>
- Open a case online in the CSC Case Management tool: <http://www.juniper.net/cm/>

To verify service entitlement by product serial number, use our Serial Number Entitlement (SNE) Tool: <https://tools.juniper.net/SerialNumberEntitlementSearch/>

## Opening a Case with JTAC

You can open a case with JTAC on the Web or by telephone.

- Use the Case Management tool in the CSC at <http://www.juniper.net/cm/> .
- Call 1-888-314-JTAC (1-888-314-5822 toll-free in the USA, Canada, and Mexico).

For international or direct-dial options in countries without toll-free numbers, visit us at <http://www.juniper.net/support/requesting-support.html>





## PART 1

# Class of Service

- [Class of Service Overview on page 3](#)



## CHAPTER 1

# Class of Service Overview

- [Understanding Class of Service on page 3](#)
- [Benefits of CoS on page 4](#)
- [CoS Across the Network on page 5](#)
- [Junos OS CoS Components on page 6](#)
- [CoS Components Packet Flow on page 7](#)
- [CoS Configuration on page 9](#)

## Understanding Class of Service

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When a network experiences congestion and delay, some packets must be dropped. Junos OS class of service (CoS) allows you to divide traffic into classes and offer various levels of throughput and packet loss when congestion occurs. This allows packet loss to happen according to the rules you configure.

For interfaces that carry IPv4, IPv6, or MPLS traffic, you can configure the Junos OS CoS features to provide multiple classes of service for different applications. On the device, you can configure multiple forwarding classes for transmitting packets, define which packets are placed into each output queue, schedule the transmission service level for each queue, and manage congestion using a random early detection (RED) algorithm.

Traffic shaping is the allocation of the appropriate amount of network bandwidth to every user and application on an interface. The appropriate amount of bandwidth is defined as cost-effective carrying capacity at a guaranteed CoS. You can use a Juniper Networks device to control traffic rate by applying classifiers and shapers.

The CoS features provide a set of mechanisms that you can use to provide differentiated services when best-effort delivery is insufficient.

Using Junos OS CoS features, you can assign service levels with different delay, jitter (delay variation), and packet loss characteristics to particular applications served by specific traffic flows. CoS is especially useful for networks supporting time-sensitive video and audio applications.



**NOTE:** Policing, scheduling, and shaping CoS services are not supported for pre-encryption and post-encryption packets going into and coming out of an IPsec VPN tunnel.

Junos OS supports the following RFCs for traffic classification and policing:

- RFC 2474, *Definition of the Differentiated Services Field in the IPv4 and IPv6*
- RFC 2475, *An Architecture for Differentiated Services*
- RFC 2597, *Assured Forwarding PHB Group*
- RFC 2598, *An Expedited Forwarding PHB*
- RFC 2697, *A Single Rate Three Color Marker*
- RFC 2698, *A Two Rate Three Color Marker*

**Related  
Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Junos OS CoS Components on page 6](#)
- [CoS Components Packet Flow on page 7](#)
- [Understanding CoS Default Settings on page 9](#)
- [CoS Device Configuration Overview on page 10](#)

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## Benefits of CoS

IP routers normally forward packets independently, without controlling throughput or delay. This type of packet forwarding, known as *best-effort service*, is as good as your network equipment and links allow. Best-effort service is sufficient for many traditional IP data delivery applications, such as e-mail or Web browsing. However, newer IP applications such as real-time video and audio (or voice) require lower delay, jitter, and packet loss than simple best-effort networks can provide.

CoS features allow a Juniper Networks device to improve its processing of critical packets while maintaining best-effort traffic flows, even during periods of congestion. Network throughput is determined by a combination of available bandwidth and delay. CoS dedicates a guaranteed minimum bandwidth to a particular service class by reducing forwarding queue delays. (The other two elements of overall network delay, serial transmission delays determined by link speeds and propagation delays determined by media type, are not affected by CoS settings.)

Normally, packets are queued for output in their order of arrival, regardless of service class. Queuing delays increase with network congestion and often result in lost packets when queue buffers overflow. CoS packet classification assigns packets to forwarding queues by service class.

Because CoS must be implemented consistently end-to-end through the network, the CoS features on the Juniper Networks device are based on IETF Differentiated Services (DiffServ) standards to interoperate with other vendors' CoS implementations.

- Related Documentation**
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
  - [Understanding Class of Service on page 3](#)

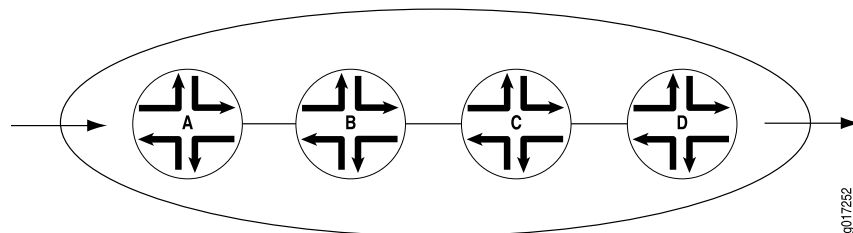
## CoS Across the Network

CoS works by examining traffic entering at the edge of your network. The edge devices classify traffic into defined service groups, which allow for the special treatment of traffic across the network. For example, voice traffic can be sent across certain links, and data traffic can use other links. In addition, the data traffic streams can be serviced differently along the network path to ensure that higher-paying customers receive better service. As the traffic leaves the network at the far edge, you can reclassify the traffic.

To support CoS, you must configure each device in the network. Generally, each device examines the packets that enter it to determine their CoS settings. These settings then dictate which packets are first transmitted to the next downstream device. In addition, the devices at the edges of your network might be required to alter the CoS settings of the packets transmitting to the neighboring network.

[Figure 1 on page 5](#) shows an example of CoS operating across an Internet Service Provider (ISP) network.

**Figure 1: CoS Across the Network**



In the ISP network shown in [Figure 1 on page 5](#), Device A is receiving traffic from your network. As each packet enters, Device A examines the packet's current CoS settings and classifies the traffic into one of the groupings defined by the ISP. This definition allows Device A to prioritize its resources for servicing the traffic streams it is receiving. In addition, Device A might alter the CoS settings (forwarding class and loss priority) of the packets to better match the ISP's traffic groups. When Device B receives the packets, it examines the CoS settings, determines the appropriate traffic group, and processes the packet according to those settings. Device B then transmits the packets to Device C, which performs the same actions. Device D also examines the packets and determines the appropriate group. Because it sits at the far end of the network, the ISP might decide once again to alter the CoS settings of the packets before Device D transmits them to the neighboring network.

- Related Documentation**
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)

- [Understanding Class of Service on page 3](#)

## Junos OS CoS Components

Junos OS supports CoS components on Juniper Networks devices as indicated in [Table 3 on page 6](#).

**Table 3: Supported Junos OS CoS Components**

Junos OS CoS Component	Description	For More Information
Code-point aliases	A code-point alias assigns a name to a pattern of code-point bits. You can use this name, instead of the bit pattern, when you configure other CoS components such as classifiers, drop-profile maps, and rewrite rules.	<a href="#">"Code-Point Aliases Overview" on page 23</a>
Classifiers	Packet classification refers to the examination of an incoming packet. This function associates the packet with a particular CoS servicing level. Two general types of classifiers are supported—behavior aggregate (BA) classifiers and multifield (MF) classifiers. When both BA and MF classifications are performed on a packet, the MF classification has higher precedence.	<a href="#">"Classification Overview" on page 13</a>
Forwarding classes	Forwarding classes allow you to group packets for transmission. Based on forwarding classes, you assign packets to output queues. The forwarding class plus the loss priority define the per-hop behavior (PHB in DiffServ) of a packet. Juniper Networks routers and services gateways support eight queues (0 through 7).	<a href="#">"Forwarding Classes Overview" on page 29</a>
Loss priorities	Loss priorities allow you to set the priority of dropping a packet. You can use the loss priority setting to identify packets that have experienced congestion.	<a href="#">"Understanding Packet Loss Priorities" on page 22</a>
Forwarding policy options	CoS-based forwarding (CBF) enables you to control next-hop selection based on a packet's class of service and, in particular, the value of the IP packet's precedence bits. For example, you can specify a particular interface or next hop to carry high-priority traffic while all best-effort traffic takes some other path.	<a href="#">"Example: Assigning a Forwarding Class to an Interface" on page 34</a>
Transmission queues	After a packet is sent to the outgoing interface on a device, it is queued for transmission on the physical media. The amount of time a packet is queued on the device is determined by the availability of the outgoing physical media as well as the amount of traffic using the interface. Juniper Networks routers and services gateways support queues 0 through 7.	<a href="#">"Transmission Scheduling Overview" on page 65</a>
Schedulers	An individual device interface has multiple queues assigned to store packets temporarily before transmission. To determine the order to service the queues, the device uses a round-robin scheduling method based on priority and the queue's weighted round-robin (WRR) credits. Junos OS schedulers allow you to define the priority, bandwidth, delay buffer size, rate control status, and RED drop profiles to be applied to a particular queue for packet transmission.	<a href="#">"Schedulers Overview" on page 43</a>

Table 3: Supported Junos OS CoS Components (*continued*)

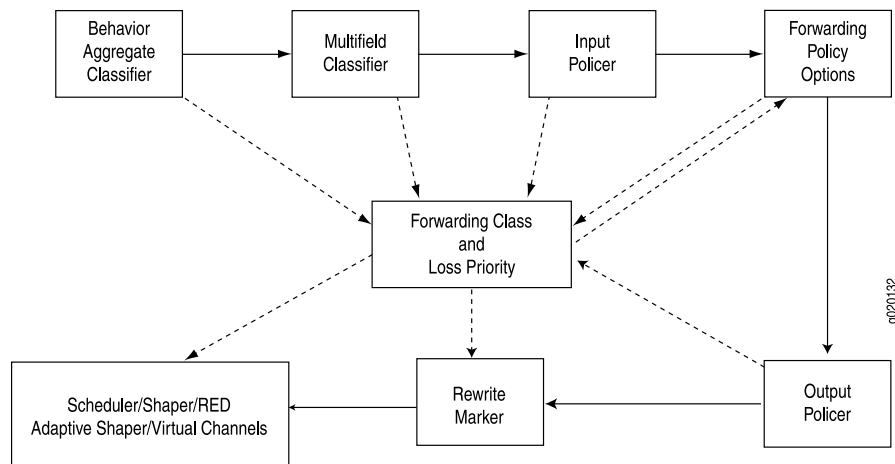
Junos OS CoS Component	Description	For More Information
Virtual channels	On Juniper Networks routers and services gateways, you can configure virtual channels to limit traffic sent from a corporate headquarters to branch offices. Virtual channels might be required when the headquarters site has an expected aggregate bandwidth higher than that of the individual branch offices. The router at the headquarters site must limit the traffic sent to each branch office router to avoid oversubscribing their links.	<a href="#">“Virtual Channels Overview” on page 147</a>
Policers for traffic classes	Policers allow you to limit traffic of a certain class to a specified bandwidth and burst size. Packets exceeding the policer limits can be discarded, or can be assigned to a different forwarding class, a different loss priority, or both. You define policers with firewall filters that can be associated with input or output interfaces.	<a href="#">“Simple Filters and Policers Overview” on page 79</a>
Rewrite rules	A rewrite rule modifies the appropriate CoS bits in an outgoing packet. Modification of CoS bits allows the next downstream device to classify the packet into the appropriate service group. Rewriting or marking outbound packets is useful when the device is at the border of a network and must alter the CoS values to meet the policies of the targeted peer.	<a href="#">“Rewrite Rules Overview” on page 73</a>

**Related Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Understanding Class of Service on page 3](#)
- [CoS Components Packet Flow on page 7](#)
- [Understanding CoS Default Settings on page 9](#)
- [CoS Device Configuration Overview on page 10](#)

## CoS Components Packet Flow

On Juniper Networks devices, you configure CoS functions using different components. These components are configured individually or in a combination to define particular CoS services. [Figure 2 on page 8](#) displays the relationship of different CoS components to each other and illustrates the sequence in which they interact.

**Figure 2: Packet Flow Through Juniper Networks Device**

Each box in [Figure 2 on page 8](#) represents a CoS component. The solid lines show the direction of packet flow in a device. The upper row indicates an incoming packet, and the lower row an outgoing packet. The dotted lines show the inputs and outputs of particular CoS components. For example, the forwarding class and loss priority are outputs of behavior aggregate classifiers and multifield classifiers and inputs for rewrite markers and schedulers.

Typically, only a combination of some components shown in [Figure 2 on page 8](#) (not all) is used to define a CoS service offering. For example, if a packet's class is determined by a behavior aggregate classifier, it is associated with a forwarding class and loss priority and does not need further classification by the multifield classifier.

This section contains the following topics:

- [CoS Process on Incoming Packets on page 8](#)
- [CoS Process on Outgoing Packets on page 9](#)

## CoS Process on Incoming Packets

Classifiers and policers perform the following operations on incoming packets:

1. A classifier examines an incoming packet and assigns a forwarding class and loss priority to it.
2. Based on the forwarding class, the packet is assigned to an outbound transmission queue.
3. Input policers meter traffic to see if traffic flow exceeds its service level. Policers might discard, change the forwarding class and loss priority, or set the PLP bit of a packet. A packet for which the PLP bit is set has an increased probability of being dropped during congestion.



## CoS Process on Outgoing Packets

The scheduler map and rewrite rules perform the following operations on outgoing packets:

1. Scheduler maps are applied to interfaces and associate the outgoing packets with a scheduler and a forwarding class.
2. The scheduler defines how the packet is treated in the output transmission queue based on the configured transmit rate, buffer size, priority, and drop profile.
  - The buffer size defines the period for which the packet is stored during congestion.
  - The scheduling priority and transmit rate determine the order in which the packet is transmitted.
  - The drop profile defines how aggressively to drop packets that are using a particular scheduler.
3. Output policers meter traffic and might change the forwarding class and loss priority of a packet if a traffic flow exceeds its service level.
4. The rewrite rule writes information to the packet (for example, EXP or DSCP bits) according to the forwarding class and loss priority of the packet.

### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Understanding Class of Service on page 3](#)
- [Junos OS CoS Components on page 6](#)
- [Understanding CoS Default Settings on page 9](#)
- [CoS Device Configuration Overview on page 10](#)

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## CoS Configuration

This section contains the following topics:

- [Understanding CoS Default Settings on page 9](#)
- [CoS Device Configuration Overview on page 10](#)

## Understanding CoS Default Settings

The Class of Service menu in J-Web allows you to configure most of the Junos OS CoS components for the IPv4 and MPLS traffic on a Juniper Networks device. You can configure forwarding classes for transmitting packets, define which packets are placed into each output queue, schedule the transmission service level for each queue, and manage congestion using a random early detection (RED) algorithm. After defining the CoS components, you must assign classifiers to the required physical and logical interfaces.

Even when you do not configure any CoS settings on your routing platform, the software performs some CoS functions to ensure that user traffic and protocol packets are

forwarded with minimum delay when the network is experiencing congestion. Some default mappings are automatically applied to each logical interface that you configure. Other default mappings, such as explicit default classifiers and rewrite rules, are in operation only if you explicitly associate them with an interface.

You can display default CoS settings by running the **show class-of-service** operational mode command.

You configure CoS when you need to override the default packet forwarding behavior of a Juniper Networks device—especially in the three areas identified in [Table 4 on page 10](#).

**Table 4: Reasons to Configure Class of Service (CoS)**

Default Behavior to Override with CoS	CoS Configuration Area
Packet classification—By default, the Juniper Networks device does not use behavior aggregate (BA) classifiers to classify packets. Packet classification applies to incoming traffic.	Classifiers
Scheduling queues—By default, the Juniper Networks device has only two queues enabled. Scheduling queues apply to outgoing traffic.	Schedulers
Packet headers—By default, the Juniper Networks device does not rewrite CoS bits in packet headers. Rewriting packet headers applies to outgoing traffic.	Rewrite rules

## CoS Device Configuration Overview

Before you begin configuring a Juniper Networks device for CoS, complete the following tasks:

- Determine whether the device needs to support different traffic streams, such as voice or video. If so, CoS helps to make sure this traffic receives more than basic best-effort packet delivery service.
- Determine whether the device is directly attached to any applications that send CoS-classified packets. If no sources are enabled for CoS, you must configure and apply rewrite rules on the interfaces facing the sources.
- Determine whether the device must support assured forwarding (AF) classes. Assured forwarding usually requires random early detection (RED) drop profiles to be configured and applied.
- Determine whether the device must support expedited forwarding (EF) classes with a policer. Policers require you to apply a burst size and bandwidth limit to the traffic flow, and set a consequence for packets that exceed these limits—usually a high loss priority, so that packets exceeding the policer limits are discarded first.

## PART 2

# Class of Service Components

- [Packet Classification on page 13](#)
- [Code-Point Aliases on page 23](#)
- [Forwarding Classes on page 29](#)
- [Schedulers on page 43](#)
- [Rewrite Rules on page 73](#)
- [CoS Filters and Policers on page 79](#)
- [Strict-Priority Queues on page 95](#)
- [RED Drop Profiles on page 109](#)
- [Adaptive Shapers for Frame Relay on page 115](#)



## CHAPTER 2

# Packet Classification

- [Classification Overview on page 13](#)
- [Default Behavior Aggregate Classification on page 16](#)
- [Sample Behavior Aggregate Classification on page 17](#)
- [Example: Configuring Behavior Aggregate Classifiers on page 19](#)
- [Understanding Packet Loss Priorities on page 22](#)

## Classification Overview

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*Packet classification* refers to the examination of an incoming packet, which associates the packet with a particular CoS servicing level. Junos operating system (OS) supports these classifiers:

- Behavior aggregate (BA) classifiers
- Multifield (MF) classifiers
- Default IP precedence classifiers

When both BA and MF classifications are performed on a packet, the MF classification has higher precedence.

In Junos OS, classifiers associate incoming packets with a forwarding class (FC) and packet loss priority (PLP), and, based on the associated FC, assign packets to output queues. A packet's FC and PLP specify the behavior of a hop, within the system, to process the packet. The per-hop behavior (PHB) comprises packet forwarding, policing, scheduling, shaping, and marking. For example, a hop can put a packet in one of the priority queues according to its FC and then manage the queues by checking the packet's PLP. Junos OS supports up to eight FCs and four PLPs.

This topic includes the following sections:

- [Behavior Aggregate Classifiers on page 14](#)
- [Multifield Classifiers on page 14](#)
- [Default IP Precedence Classifier on page 15](#)

## Behavior Aggregate Classifiers

A BA classifier operates on a packet as it enters the device. Using BA classifiers, the device aggregates different types of traffic into a single FC so that all the types of traffic will receive the same forwarding treatment. The CoS value in the packet header is the single field that determines the CoS settings applied to the packet. BA classifiers allow you to set a packet's FC and PLP based on the Differentiated Services (DiffServ) code point (DSCP) value, DSCP IPv4 value, DSCP IPv6 value, IP precedence value, MPLS EXP bits, or IEEE 802.1p value. The default classifier is based on the IP precedence value. For more information, see [“Default IP Precedence Classifier” on page 15](#).

Junos OS performs BA classification for a packet by examining its Layer 2, Layer 3, and related CoS parameters, as shown in [Table 5 on page 14](#).

**Table 5: BA Classification**

Layer	CoS Parameter
Layer 2	IEEE 802.1p value: User Priority
Layer 3	IPv4 precedence IPv4 Differentiated Services code point (DSCP) value IPv6 DSCP value



**NOTE:** A BA classifier evaluates Layer 2 and Layer 3 parameters independently. The results from Layer 2 parameters override the results from the Layer 3 parameters.

## Multifield Classifiers

An MF classifier is a second means of classifying traffic flows. Unlike the BA classifier, an MF classifier can examine multiple fields in the packet—for example, the source and destination address of the packet, or the source and destination port numbers of the packet. With MF classifiers, you set the FC and PLP based on firewall filter rules.



**NOTE:** For a specified interface, you can configure both an MF classifier and a BA classifier without conflicts. Because the classifiers are always applied in sequential order (the BA classifier followed by the MF classifier) any BA classification result is overridden by an MF classifier if they conflict.

Junos OS performs MF traffic classification by directly scrutinizing multiple fields of a packet to classify a packet. This avoids having to rely on the output of the previous BA traffic classification. Junos OS can simultaneously check a packet's data for Layers 2, 3, 4, and 7, as shown in [Table 6 on page 15](#).

Table 6: MF Classification

Layer	CoS Parameter
Layer 2	IEEE 802.1Q: VLAN ID
	IEEE 802.1p: User priority
Layer 3	IP precedence value
	DSCP or DSCP IPv6 value
	Source IP address
	Destination IP address
	Protocol
	ICMP: Code and type
Layer 4	TCP/UDP: Source port
	TCP/UDP: Destination port
	TCP: Flags
	AH/ESP: SPI
Layer 7	Not supported for this release.

Using Junos OS, you configure an MF classifier with a firewall filter and its associated match conditions. This enables you to use any filter match criterion to locate packets that require classification.

### Default IP Precedence Classifier

With Junos OS, all logical interface are automatically assigned a default IP precedence classifier when the logical interface is configured. This default traffic classifier maps IP precedence values to an FC and a PLP as shown in [Table 7 on page 15](#). These mapping results are in effect for an ingress packet until the packet is further processed by another classification method.

Table 7: Default IP Precedence Classifier

IP Precedence CoS Values	Forwarding Class	Packet Loss Priority
000	best-effort	low
001	best-effort	high
010	best-effort	low
011	best-effort	high
100	best-effort	low

Table 7: Default IP Precedence Classifier (*continued*)

IP Precedence CoS Values	Forwarding Class	Packet Loss Priority
101	best-effort	high
110	network-control	low
111	network-control	high

**Related Documentation**

- [Junos OS Security Configuration Guide](#)
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Default Behavior Aggregate Classification on page 16](#)
- [Sample Behavior Aggregate Classification on page 17](#)
- [Example: Configuring Behavior Aggregate Classifiers on page 19](#)

## Default Behavior Aggregate Classification

Table 8 on page 16 shows the forwarding class (FC) and packet loss priority (PLP) that are assigned by default to each well-known Differentiated Services (DiffServ) code point (DSCP). Although several DSCPs map to the expedited-forwarding (ef) and assured-forwarding (af) classes, by default no resources are assigned to these forwarding classes. All af classes other than af1x are mapped to best-effort, because RFC 2597, *Assured Forwarding PHB Group*, prohibits a node from aggregating classes. Assignment to the best-effort FC implies that the node does not support that class. You can modify the default settings through configuration.

Table 8: Default Behavior Aggregate Classification

DSCP and DSCP IPv6 Alias	Forwarding Class	Packet Loss Priority
ef	expedited-forwarding	low
af11	assured-forwarding	low
af12	assured-forwarding	high
af13	assured-forwarding	high
af21	best-effort	low
af22	best-effort	low
af23	best-effort	low
af31	best-effort	low
af32	best-effort	low



Table 8: Default Behavior Aggregate Classification (*continued*)

DSCP and DSCP IPv6 Alias	Forwarding Class	Packet Loss Priority
af33	best-effort	low
af41	best-effort	low
af42	best-effort	low
af43	best-effort	low
be	best-effort	low
cs1	best-effort	low
cs2	best-effort	low
cs3	best-effort	low
cs4	best-effort	low
cs5	best-effort	low
nc1/cs6	network-control	low
nc2/cs7	network-control	low
other	best-effort	low

- Related Documentation**
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
  - [Classification Overview on page 13](#)
  - [Sample Behavior Aggregate Classification on page 17](#)
  - [Example: Configuring Behavior Aggregate Classifiers on page 19](#)
  - [Understanding Packet Loss Priorities on page 22](#)

## Sample Behavior Aggregate Classification

Table 9 on page 18 shows the device forwarding classes (FCs) associated with each well-known Differentiated Services (DiffServ) code point (DSCP) and the resources assigned to the output queues for a sample DiffServ CoS implementation. This example assigns expedited forwarding to queue 1 and a subset of the assured FCs (afx) to queue 2, and distributes resources among all four forwarding classes. Other DiffServ-based implementations are possible.

Table 9: Sample Behavior Aggregate Classification Forwarding Classes and Queues

DSCP and DSCP IPv6 Alias	DSCP and DSCP IPv6 Bits	Forwarding Class	Packet Loss Priority	Queue
ef	101110	expedited-forwarding	low	1
af11	001010	assured-forwarding	low	2
af12	001100	assured-forwarding	high	2
af13	001110	assured-forwarding	high	2
af21	010010	best-effort	low	0
af22	010100	best-effort	low	0
af23	010110	best-effort	low	0
af31	011010	best-effort	low	0
af32	011100	best-effort	low	0
af33	011110	best-effort	low	0
af41	100010	best-effort	low	0
af42	100100	best-effort	low	0
af43	100110	best-effort	low	0
be	000000	best-effort	low	0
cs1	0010000	best-effort	low	0
cs2	010000	best-effort	low	0
cs3	011000	best-effort	low	0
cs4	100000	best-effort	low	0
cs5	101000	best-effort	low	0
nc1/cs6	110000=	network-control	low	3
nc2/cs7	111000=	network-control	low	3
other	—	best-effort	low	0

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Classification Overview on page 13](#)
- [Default Behavior Aggregate Classification on page 16](#)
- [Example: Configuring Behavior Aggregate Classifiers on page 19](#)
- [Understanding Packet Loss Priorities on page 22](#)

## Example: Configuring Behavior Aggregate Classifiers

This example shows how to configure behavior aggregate classifiers for a device to determine forwarding treatment of packets.

- [Requirements on page 19](#)
- [Overview on page 19](#)
- [Configuration on page 20](#)
- [Verification on page 22](#)

### Requirements

Before you begin, determine the forwarding class and PLP that are assigned by default to each well-known DSCP that you want to configure for the behavior aggregate classifier. See [“Default Behavior Aggregate Classification” on page 16](#).

### Overview

You configure behavior aggregate classifiers to classify packets that contain valid DSCPs to appropriate queues. Once configured, you must apply the behavior aggregate classifier to the correct interfaces. You can override the default IP precedence classifier by defining a classifier and applying it to a logical interface. To define new classifiers for all code point types, include the **classifiers** statement at the **[edit class-of-service]** hierarchy level.

In this example, you set the DSCP behavior aggregate classifier to ba-classifier as the default DSCP map. You set a best-effort forwarding class as be-class, an expedited forwarding class as ef-class, an assured forwarding class as af-class, and a network control forwarding class as nc-class. Finally, you apply the behavior aggregate classifier to an interface called ge-0/0/0.

[Table 10 on page 19](#) shows how the behavior aggregate classifier assigns loss priorities, to incoming packets in the four forwarding classes.

**Table 10: Sample ba-classifier Loss Priority Assignments**

mf-classifier Forwarding Class	For CoS Traffic Type	ba-classifier Assignments
be-class	Best-effort traffic	High-priority code point: 000001
ef-class	Expedited forwarding traffic	High-priority code point: 101111

Table 10: Sample ba-classifier Loss Priority Assignments (*continued*)

mf-classifier Forwarding Class	For CoS Traffic Type	ba-classifier Assignments
af-class	Assured forwarding traffic	High-priority code point: 001100
nc-class	Network control traffic	High-priority code point: 110001

## Configuration

### CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service classifiers dscp ba-classifier import default
set class-of-service classifiers dscp ba-classifier forwarding-class be-class loss-priority
  high code-points 000001
set class-of-service classifiers dscp ba-classifier forwarding-class ef-class loss-priority
  high code-points 101111
set class-of-service classifiers dscp ba-classifier forwarding-class af-class loss-priority
  high code-points 001100
set class-of-service classifiers dscp ba-classifier forwarding-class nc-class loss-priority
  high code-points 110001
set class-of-service interfaces ge-0/0/0 unit 0 classifiers dscp ba-classifier
```

### Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see *Using the CLI Editor in Configuration Mode* in the [Junos OS CLI User Guide](#).

To configure behavior aggregate classifiers for a device:

1. Configure the class of service.  

```
[edit]
user@host# edit class-of-service
```
2. Configure behavior aggregate classifiers for DiffServ CoS.  

```
[edit class-of-service]
user@host# edit classifiers dscp ba-classifier
user@host# set import default
```
3. Configure a best-effort forwarding class classifier.  

```
[edit class-of-service classifiers dscp ba-classifier]
user@host# set forwarding-class be-class loss-priority high code-points 000001
```
4. Configure an expedited forwarding class classifier.  

```
[edit class-of-service classifiers dscp ba-classifier]
user@host# set forwarding-class ef-class loss-priority high code-points 101111
```
5. Configure an assured forwarding class classifier.  

```
[edit class-of-service classifiers dscp ba-classifier]
user@host# set forwarding-class af-class loss-priority high code-points 001100
```

6. Configure a network control forwarding class classifier.

```
[edit class-of-service classifiers dscp ba-classifier]
user@host# set forwarding-class nc-class loss-priority high code-points 110001
```

7. Apply the behavior aggregate classifier to an interface.

```
[edit]
user@host# set class-of-service interfaces ge-0/0/0 unit 0 classifiers dscp
ba-classifier
```



**NOTE:** You can use interface wildcards for interface-name and logical-unit-number.

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service
classifiers {
  dscp ba-classifier {
    import default;
    forwarding-class be-class {
      loss-priority high code-points 000001;
    }
    forwarding-class ef-class {
      loss-priority high code-points 101111;
    }
    forwarding-class af-class {
      loss-priority high code-points 001100;
    }
    forwarding-class nc-class {
      loss-priority high code-points 110001;
    }
  }
}
interfaces {
  ge-0/0/0 {
    unit 0 {
      classifiers {
        dscp ba-classifier;
      }
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

Confirm that the configuration is working properly.

- [Verifying Behavior Aggregate Classifiers on page 22](#)

---

### Verifying Behavior Aggregate Classifiers

**Purpose** Verify that the behavior aggregate classifiers were configured properly on the device.

**Action** From configuration mode, enter the **show class-of-service** command.

**Related  
Documentation**

- [Junos OS Interfaces Configuration Guide for Security Devices](#)
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Classification Overview on page 13](#)
- [Sample Behavior Aggregate Classification on page 17](#)
- [Understanding Packet Loss Priorities on page 22](#)

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## Understanding Packet Loss Priorities

Packet loss priorities (PLPs) allow you to set the priority for dropping packets. You can use the PLP setting to identify packets that have experienced congestion. Typically, you mark packets exceeding some service level with a high loss priority—that is, a greater likelihood of being dropped. You set PLP by configuring a classifier or a policer. The PLP is used later in the work flow to select one of the drop profiles used by random early detection (RED).

You can configure the PLP bit as part of a congestion control strategy. The PLP bit can be configured on an interface or in a filter. A packet for which the PLP bit is set has an increased probability of being dropped during congestion.

**Related  
Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Classification Overview on page 13](#)
- [Default Behavior Aggregate Classification on page 16](#)
- [Sample Behavior Aggregate Classification on page 17](#)
- [Example: Configuring Behavior Aggregate Classifiers on page 19](#)

## CHAPTER 3

# Code-Point Aliases

- [Code-Point Aliases Overview on page 23](#)
- [Default CoS Values and Aliases on page 24](#)
- [Example: Defining Code-Point Aliases for Bits on page 26](#)

### Code-Point Aliases Overview

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A code-point alias assigns a name to a pattern of code-point bits. You can use this name instead of the bit pattern when you configure other class-of-service (CoS) components, such as classifiers, drop-profile maps, and rewrite rules.

When you configure classes and define classifiers, you can refer to the markers by alias names. You can configure user-defined classifiers in terms of alias names. If the value of an alias changes, it alters the behavior of any classifier that references it.

The following types of code points are supported by Junos operating system (OS):

- DSCP—Defines aliases for DiffServ code point (DSCP) IPv4 values.  
You can refer to these aliases when you configure classes and define classifiers.
- DSCP-IPv6—Defines aliases for DSCP IPv6 values.  
You can refer to these aliases when you configure classes and define classifiers.
- EXP—Defines aliases for MPLS EXP bits.  
You can map MPLS EXP bits to the device forwarding classes.
- inet-precedence—Defines aliases for IPv4 precedence values.

Precedence values are modified in the IPv4 type-of-service (TOS) field and mapped to values that correspond to levels of service.

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Default CoS Values and Aliases on page 24](#)
- [Example: Defining Code-Point Aliases for Bits on page 26](#)

## Default CoS Values and Aliases

Table 11 on page 24 shows the default mapping between the standard aliases and the bit values.

**Table 11: Standard CoS Aliases and Bit Values**

CoS Value Type	Alias	Bit Value
DSCP and DSCP IPv6	ef	101110
	af11	001010
	af12	001100
	af13	001110
	af21	010010
	af22	010100
	af23	010110
	af31	011010
	af32	011100
	af33	011110
	af41	100010
	af42	100100
	af43	100110
	be	000000
	cs1	001000
	cs2	010000
	cs3	011000
	cs4	100000
	cs5	101000
	nc1/cs6	110000
	nc2/cs7	111000



Table 11: Standard CoS Aliases and Bit Values (*continued*)

CoS Value Type	Alias	Bit Value
MPLS EXP	be	000
	be1	001
	ef	010
	ef1	011
	af11	100
	af12	101
	nc1/cs6	110
	nc2/cs7	111
IEEE 802.1	be	000
	be1	001
	ef	010
	ef1	011
	af11	100
	af12	101
	nc1/cs6	110
	nc2/cs7	111
IP precedence	be	000
	be1	001
	ef	010
	ef1	011
	af11	100
	af12	101
	nc1/cs6	110
	nc2/cs7	111

**Related Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Code-Point Aliases Overview on page 23](#)
- [Example: Defining Code-Point Aliases for Bits on page 26](#)

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## Example: Defining Code-Point Aliases for Bits

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This example shows how to define code-point aliases for bits on a device.

- [Requirements on page 26](#)
- [Overview on page 26](#)
- [Configuration on page 26](#)
- [Verification on page 27](#)

### Requirements

Before you begin, determine which default mapping to use. See [“Default CoS Values and Aliases” on page 24](#).

### Overview

In this example, you configure class of service and specify names and values for the CoS code-point aliases that you want to configure. Finally, you specify CoS value using the appropriate formats.

### Configuration

**Step-by-Step Procedure**

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see [Using the CLI Editor in Configuration Mode](#) in the *Junos OS CLI User Guide*.

To define code-point aliases for bits on a device:

1. Configure class of service.  

```
[edit]  
user@host# edit class-of-service
```
2. Specify CoS values.  

```
[edit class-of-service]  
user@host# set code-point-aliases dscp my1 110001  
user@host# set code-point-aliases dscp my2 101110  
user@host# set code-point-aliases dscp be 000001  
user@host# set code-point-aliases dscp cs7 110000
```
3. If you are done configuring the device, commit the configuration.  

```
[edit]  
user@host# commit
```

## Verification

To verify the configuration is working properly, enter the **show class-of-service code-point-aliases dscp** command.

- Related Documentation**
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
  - [Code-Point Aliases Overview on page 23](#)



## CHAPTER 4

# Forwarding Classes

- [Forwarding Classes Overview on page 29](#)
- [Example: Assigning Forwarding Classes to Output Queues on page 31](#)
- [Example: Assigning a Forwarding Class to an Interface on page 34](#)
- [Example: Configuring Forwarding Classes on page 35](#)
- [Services Processing Card High-Priority Queue on page 39](#)

### Forwarding Classes Overview

---

Forwarding classes (FCs) allow you to group packets for transmission and to assign packets to output queues. The forwarding class and the loss priority define the per-hop behavior (PHB in DiffServ) of a packet.

Juniper Networks devices support eight queues (0 through 7). For a classifier to assign an output queue (default queues 0 through 3) to each packet, it must associate the packet with one of the following forwarding classes:

- Expedited forwarding (EF)—Provides a low-loss, low-latency, low-jitter, assured-bandwidth, end-to-end service.
- Assured forwarding (AF)—Provides a group of values you can define and includes four subclasses—AF1, AF2, AF3, and AF4—each with three drop probabilities (low, medium, and high).
- Best effort (BE)—Provides no service profile. For the BE forwarding class, loss priority is typically not carried in a class-of-service (CoS) value, and random early detection (RED) drop profiles are more aggressive.
- Network Control (NC)—This class is typically high priority because it supports protocol control.

In addition to behavior aggregate (BA) and multifield (MF) classification, the forwarding class (FC) of a packet can be directly determined by the logical interface that receives the packet. The packet FC can be configured using CLI commands, and if configured, this FC overrides the FC from any BA classification that was previously configured on the logical interface.

The following CLI command can assign an FC directly to packets received at a logical interface:

[edit class-of-service interfaces interface-name unit logical-unit-number]  
forwarding-class class-name;

This section contains the following topics:

- [Forwarding Class Queue Assignments on page 30](#)
- [Forwarding Policy Options on page 31](#)

## Forwarding Class Queue Assignments

Juniper Networks devices have eight queues built into the hardware. By default, four queues are assigned to four FCs. [Table 12 on page 30](#) shows the four default FCs and queues that Juniper Networks classifiers assign to packets, based on the class-of-service (CoS) values in the arriving packet headers.



**NOTE:** Queues 4 through 7 have no default assignments to FCs and are not mapped. To use queues 4 through 7, you must create custom FC names and map them to the queues.

By default, all incoming packets, except the IP control packets, are assigned to the FC associated with queue 0. All IP control packets are assigned to the FC associated with queue 3.

**Table 12: Default Forwarding Class Queue Assignments**

Forwarding Queue	Forwarding Class	Forwarding Class Description
Queue 0	best-effort (BE)	The Juniper Networks device does not apply any special CoS handling to packets with 000000 in the DiffServ field, a backward compatibility feature. These packets are usually dropped under congested network conditions.
Queue 1	expedited-forwarding (EF)	<p>The Juniper Networks device delivers assured bandwidth, low loss, low delay, and low delay variation (jitter) end-to-end for packets in this service class.</p> <p>Devices accept excess traffic in this class, but in contrast to assured forwarding, out-of-profile expedited-forwarding packets can be forwarded out of sequence or dropped.</p>
Queue 2	assured-forwarding (AF)	<p>The Juniper Networks device offers a high level of assurance that the packets are delivered as long as the packet flow from the customer stays within a certain service profile that you define.</p> <p>The device accepts excess traffic, but applies a random early detection (RED) drop profile to determine whether the excess packets are dropped and not forwarded.</p> <p>Three drop probabilities (low, medium, and high) are defined for this service class.</p>

Table 12: Default Forwarding Class Queue Assignments (*continued*)

Forwarding Queue	Forwarding Class	Forwarding Class Description
Queue 3	network-control (NC)	<p>The Juniper Networks device delivers packets in this service class with a low priority. (These packets are not delay sensitive.)</p> <p>Typically, these packets represent routing protocol hello or keepalive messages. Because loss of these packets jeopardizes proper network operation, delay is preferable to discard.</p>

## Forwarding Policy Options

CoS-based forwarding (CBF) enables you to control next-hop selection based on a packet's CoS and, in particular, the value of the IP packet's precedence bits. For example, you can specify a particular interface or next hop to carry high-priority traffic while all best-effort traffic takes some other path. CBF allows path selection based on FC. When a routing protocol discovers equal-cost paths, it can either pick a path at random or load-balance the packets across the paths, through either hash selection or round-robin selection.

A forwarding policy also allows you to create CoS classification overrides. You can override the incoming CoS classification and assign the packets to an FC based on the packets' input interfaces, input precedence bits, or destination addresses. When you override the classification of incoming packets, any mappings you configured for associated precedence bits or incoming interfaces to output transmission queues are ignored.

### Related Documentation

- [Junos OS Security Configuration Guide](#)
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Example: Assigning Forwarding Classes to Output Queues on page 31](#)
- [Example: Assigning a Forwarding Class to an Interface on page 34](#)
- [Example: Configuring Forwarding Classes on page 35](#)

## Example: Assigning Forwarding Classes to Output Queues

This example shows how to assign forwarding classes to output queues.

- [Requirements on page 31](#)
- [Overview on page 32](#)
- [Configuration on page 32](#)
- [Verification on page 33](#)

## Requirements

Before you begin, determine the MF classifier. See “[Example: Configuring and Applying a Firewall Filter for a Multifield Classifier](#)” on page 89.

## Overview

In this example, you configure class of service and assign best-effort traffic to queue 0 as be-class, expedited forwarding traffic to queue 1 as ef-class, assured forwarding traffic to queue 2 as af-class, and network control traffic to queue 3 as nc-class.

You must assign the forwarding classes established by the MF classifier to output queues. [Table 13 on page 32](#) shows how this example assigns output queues.

**Table 13: Sample Output Queue Assignments for mf-classifier Forwarding Queues**

mf-classifier Forwarding Class	For Traffic Type	Output Queue
be-class	Best-effort traffic	Queue 0
ef-class	Expedited forwarding traffic	Queue 1
af-class	Assured forwarding traffic	Queue 2
nc-class	Network control traffic	Queue 3

## Configuration

**CLI Quick Configuration** To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service forwarding-classes queue 0 be-class
set class-of-service forwarding-classes queue 1 ef-class
set class-of-service forwarding-classes queue 2 af-class
set class-of-service forwarding-classes queue 3 nc-class
```

**Step-by-Step Procedure** The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see [Using the CLI Editor in Configuration Mode in the Junos OS CLI User Guide](#).

To assign forwarding classes to output queues:

1. Configure class of service.  

```
[edit]
user@host# edit class-of-service forwarding-classes
```
2. Assign best-effort traffic to queue 0.  

```
[edit class-of-service forwarding-classes]
user@host# set queue 0 be-class
```
3. Assign expedited forwarding traffic to queue 1.  

```
[edit class-of-service forwarding-classes]
user@host# set queue 1 ef-class
```
4. Assign assured forwarding traffic to queue 2.



```
[edit class-of-service forwarding-classes]
user@host# set queue 2 af-class
```

5. Assign network control traffic to queue 3.

```
[edit class-of-service forwarding-classes]
user@host# set queue 3 nc-class
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service
forwarding-classes {
  queue 0 be-class;
  queue 1 ef-class;
  queue 2 af-class;
  queue 3 nc-class;
}
```

If you are done configuring the device, enter **commit** from configuration mode.



**NOTE:** You cannot commit a configuration that assigns the same forwarding class to two different queues.

## Verification

Confirm that the configuration is working properly.

- [Verifying Forwarding Classes Are Assigned to Output Queues on page 33](#)

### Verifying Forwarding Classes Are Assigned to Output Queues

**Purpose** Verify that the forwarding classes are properly assigned to output queues.

**Action** From configuration mode, enter the **show class-of-service** command.

**Related Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Forwarding Classes Overview on page 29](#)
- [Example: Assigning a Forwarding Class to an Interface on page 34](#)
- [Example: Configuring Forwarding Classes on page 35](#)

## Example: Assigning a Forwarding Class to an Interface

---

This example shows how to assign a forwarding class to an interface.

- [Requirements on page 34](#)
- [Overview on page 34](#)
- [Configuration on page 34](#)
- [Verification on page 34](#)

### Requirements

No special configuration beyond device initialization is required before configuring this feature.

### Overview

On a device, you can configure fixed classification on a logical interface by specifying a forwarding class to be applied to all packets received by the logical interface, regardless of the packet contents.

In this example, you configure class of service, create interface ge-3/0/0 unit 0 and then, you then set forwarding class to assured-forwarding.

All packets coming into the device from the ge-3/0/0 unit 0 interface are assigned to the assured-forwarding forwarding class.

### Configuration

#### Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see *Using the CLI Editor in Configuration Mode* in the *Junos OS CLI User Guide*.

To assign a forwarding class to an interface:

1. Configure class of service and assign the interface.  

```
[edit]  
user@host# edit class-of-service interfaces ge-3/0/0 unit 0
```
2. Specify the forwarding class.  

```
[edit class-of-service interfaces ge-3/0/0 unit 0]  
user@host# set forwarding-class assured-forwarding
```
3. If you are done configuring the device, commit the configuration.  

```
[edit]  
user@host# commit
```

### Verification

To verify the configuration is working properly, enter the **show class-of-service** command.

**Related Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Forwarding Classes Overview on page 29](#)
- [Example: Assigning Forwarding Classes to Output Queues on page 31](#)
- [Example: Configuring Forwarding Classes on page 35](#)

## Example: Configuring Forwarding Classes

---

By default on all platforms, four output queues are mapped to four FCs as shown in [“Forwarding Classes Overview” on page 29](#). On Juniper Networks devices, you can configure up to eight FCs and eight queues.

To configure up to eight FCs, include the **queue** statement at the **[edit class-of-service forwarding-classes]** hierarchy level:

```
[edit class-of-service forwarding-classes]
queue queue-number class-name;
```

The output queue number can be from 0 through 7, and you must map the forwarding classes one-to-one with the output queues. The default scheduler transmission rate and buffer size percentages for queues 0 through 7 are 95, 0, 0, 5, 0, 0, 0, and 0 percent, respectively.

For example, to configure a one-to-one mapping between eight FCs and eight queues, you would use the following configuration:

```
[edit class-of-service]
forwarding-classes {
  queue 0 be;
  queue 1 ef;
  queue 2 af;
  queue 3 nc;
  queue 4 ef1;
  queue 5 ef2;
  queue 6 af1;
  queue 7 nc1;
}
```

**Defining Eight Classifiers**

```
[edit class-of-service]
classifiers {
  dscp dscp-table {
    forwarding-class ef {
      loss-priority low code-points [101000, 101001];
      loss-priority high code-points [101010, 101011];
    }
    forwarding-class af {
      loss-priority low code-points [010000, 010001];
      loss-priority high code-points [010010, 010011];
    }
    forwarding-class be {
      loss-priority low code-points [000000];
    }
    forwarding-class nc {
```

```

        loss-priority low code-points [111000];
    }
    forwarding-class ef1 {
        loss-priority low code-points [101100, 101101];
        loss-priority high code-points [101110];
    }
    forwarding-class af1 {
        loss-priority high code-points [101110];
    }
    forwarding-class ef2 {
        loss-priority low code-points [101111];
    }
    forwarding-class nc1 {
        loss-priority low code-points [111001];
    }
}
}

```

#### Adding Eight Schedulers to a Scheduler Map

Configure a custom scheduler map that applies globally to all interfaces, except those that are restricted to four queues:

```

[edit class-of-service]
scheduler-maps {
    sched {
        forwarding-class be scheduler Q0;
        forwarding-class ef scheduler Q1;
        forwarding-class af scheduler Q2;
        forwarding-class nc scheduler Q3;
        forwarding-class ef1 scheduler Q4;
        forwarding-class ef2 scheduler Q5;
        forwarding-class af1 scheduler Q6;
        forwarding-class nc1 scheduler Q7;
    }
}
schedulers {
    Q0 {
        transmit-rate percent 25;
        buffer-size percent 25;
        priority low;
        drop-profile-map loss-priority any protocol both drop-default;
    }
    Q1 {
        buffer-size temporal 2000;
        priority strict-high;
        drop-profile-map loss-priority any protocol both drop-ef;
    }
    Q2 {
        transmit-rate percent 35;
        buffer-size percent 35;
        priority low;
        drop-profile-map loss-priority any protocol both drop-default;
    }
    Q3 {
        transmit-rate percent 5;
        buffer-size percent 5;
        drop-profile-map loss-priority any protocol both drop-default;
    }
}

```

```

}
Q4 {
    transmit-rate percent 5;
    priority high;
    drop-profile-map loss-priority any protocol both drop-ef;
}
Q5 {
    transmit-rate percent 10;
    priority high;
    drop-profile-map loss-priority any protocol both drop-ef;
}
Q6 {
    transmit-rate remainder;
    priority low;
    drop-profile-map loss-priority any protocol both drop-default;
}
Q7 {
    transmit-rate percent 5;
    priority high;
    drop-profile-map loss-priority any protocol both drop-default;
}
}

```

#### Configuring an IP Precedence Classifier and Rewrite Tables

```

[edit class-of-service]
classifiers {
    inet-precedence inet-classifier {
        forwarding-class be {
            loss-priority low code-points 000;
        }
        forwarding-class af11 {
            loss-priority high code-points 001;
        }
        forwarding-class ef {
            loss-priority low code-points 010;
        }
        forwarding-class nc1 {
            loss-priority high code-points 011;
        }
        forwarding-class {
            loss-priority low code-points 100;
        }
        forwarding-class af12 {
            loss-priority high code-points 101;
        }
        forwarding-class ef1 {
            loss-priority low code-points 110;
        }
        forwarding-class nc2 {
            loss-priority high code-points 111;
        }
    }
}
exp exp-rw-table {
    forwarding-class be {
        loss-priority low code-point 000;
    }
}

```

```

forwarding-class af11 {
    loss-priority high code-point 001;
}
forwarding-class ef {
    loss-priority low code-point 010;
}
forwarding-class nc1 {
    loss-priority high code-point 111;
}
forwarding-class be1 {
    loss-priority low code-point 100;
}
forwarding-class af12 {
    loss-priority high code-point 101;
}
forwarding-class ef1 {
    loss-priority low code-point 110;
}
forwarding-class nc2 {
    loss-priority low code-point 111;
}
}
inet-precedence inet-rw-table {
    forwarding-class be {
        loss-priority low code-point 000;
    }
    forwarding-class af11 {
        loss-priority high code-point 001;
    }
    forwarding-class ef1 {
        loss-priority low code-point 010;
    }
    forwarding-class nc1 {
        loss-priority low code-point 111;
    }
    forwarding-class be1 {
        loss-priority low code-point 100;
    }
    forwarding-class af12 {
        loss-priority high code-point 101;
    }
    forwarding-class ef1 {
        loss-priority low code-point 111;
    }
    forwarding-class nc2 {
        loss-priority low code-point 110;
    }
}

```

#### Configuring an IDP Policy with a Forwarding Class

Configure an IDP policy with a forwarding class as an action to rewrite DSCP values of IP packets:

```

[edit class-of-service]
security idp idp-policy policy_name rulebase-ips rule rule_name {
    then {
        action {

```

```
class-of-service {  
    forwarding-class forwarding-class-name;  
    dscp-code-point value;  
}  
}  
}
```

**Related  
Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Junos OS Security Configuration Guide](#)
- [Forwarding Classes Overview on page 29](#)
- [Example: Assigning Forwarding Classes to Output Queues on page 31](#)
- [Example: Assigning a Forwarding Class to an Interface on page 34](#)

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## Services Processing Card High-Priority Queue

- [Understanding the SPC High-Priority Queue on page 39](#)
- [Example: Configuring the SPC High-Priority Queue on page 40](#)

### Understanding the SPC High-Priority Queue

The Services Processing Card (SPC) on SRX1400, SRX3000 line, and SRX5000 line devices provides processing power to run integrated services such as firewall, IPsec, and IDP. All traffic traversing the SRX Series device is passed to an SPC to have service processing applied. Junos OS provides a configuration option to enable packets with specific Differentiated Services (DiffServ) code points (DSCP) precedence bits to enter a high-priority queue on the SPC. The Services Processing Unit (SPU) draws packets from the high-priority queue and only draws packets from a low-priority queue when the high-priority queue is empty. This feature can reduce overall latency for real-time traffic, such as voice traffic.

To designate packets for the high-priority or low-priority queues, use the **spu-priority** configuration statement at the **[edit class-of-service forwarding-classes class]** hierarchy level. A value of **high** places packets into the high-priority queue, and a value of **low** places packets into the low-priority queue.

**Related  
Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Example: Configuring the SPC High-Priority Queue on page 40](#)
- [Forwarding Classes Overview on page 29](#)

## Example: Configuring the SPC High-Priority Queue

This example shows how to configure a forwarding class for the high-priority queue on the SPC.

- [Requirements on page 40](#)
- [Overview on page 40](#)
- [Configuration on page 40](#)
- [Verification on page 41](#)

### Requirements

This example uses the following hardware and software components:

- SRX1400, SRX3000 line, or SRX5000 line device
- Junos OS Release 11.4R2 or later

### Overview

This example defines the following forwarding classes and assigns a queue number to each class:

Forwarding Class	Queue Number
best-effort	0
assured-forwarding	1
network-control	3
expedited-forwarding	2

The expedited-forwarding class is configured for the high-priority queue on the SPC.

### Configuration

#### CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service forwarding-classes class best-effort queue-num 0
set class-of-service forwarding-classes class assured-forwarding queue-num 1
set class-of-service forwarding-classes class network-control queue-num 3
set class-of-service forwarding-classes class expedited-forwarding queue-num 2
spu-priority high
```



**Step-by-Step Procedure** The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see *Using the CLI Editor in Configuration Mode* in the [Junos OS CLI User Guide](#).

To configure the high-priority queue on the SPC:

1. Define forwarding classes and assign queue numbers.

```
[edit class-of-service forwarding-classes]
user@host# set class best-effort queue-num 0
user@host# set class assured-forwarding queue-num 1
user@host# set class network-control queue-num 3
user@host# set class expedited-forwarding queue-num 2
```

2. Configure the SPC high-priority queue.

```
[edit class-of-service forwarding-classes]
user@host# set class expedited-forwarding spu-priority high
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service forwarding-classes** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service forwarding-classes
class best-effort queue-num 0;
class assured-forwarding queue-num 1;
class network-control queue-num 3;
class expedited-forwarding queue-num 2 spu-priority high;
```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

### Verifying SPU High-Priority Queue Mapping

**Purpose** Verify that the forwarding class is mapped to the SPU high-priority queue.

**Action** From operational mode, enter the **show class-of-service forwarding-class** command.

```
user@host> show class-of-service forwarding-class
```

Forwarding class	ID	Queue	Restricted queue	Fabric
priority Policing priority SPU priority				
best-effort	0	0	0	low
normal	low			
expedited-forwarding	1	1	1	low
normal	high			
assured-forwarding	2	2	2	low
normal	low			
network-control	3	3	3	low
normal	low			

**Related Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Understanding the SPC High-Priority Queue on page 39](#)

- [Example: Configuring Forwarding Classes on page 35](#)

## CHAPTER 5

# Schedulers

- [Schedulers Overview on page 43](#)
- [Default Scheduler Settings on page 48](#)
- [Example: Configuring Class-of-Service Schedulers on page 49](#)
- [Scheduler Buffer Size Overview on page 53](#)
- [Example: Configuring a Large Delay Buffer on a Channelized T1 Interface on page 55](#)
- [Configuring Large Delay Buffers in CoS on page 58](#)
- [Example: Configuring and Applying Scheduler Maps on page 63](#)
- [Transmission Scheduling Overview on page 65](#)
- [Excess Bandwidth Sharing and Minimum Logical Interface Shaping on page 67](#)
- [Excess Bandwidth Sharing Proportional Rates on page 67](#)
- [Calculated Weights Mapped to Hardware Weights on page 68](#)
- [Weight Allocation with Only Shaping Rates or Unshaped Logical Interfaces on page 69](#)
- [Shared Bandwidth Among Logical Interfaces on page 70](#)

## Schedulers Overview

---

You use *schedulers* to define the properties of output queues. These properties include the amount of interface bandwidth assigned to the queue, the size of the memory buffer allocated for storing packets, the priority of the queue, and the random early detection (RED) drop profiles associated with the queue.

You associate the schedulers with forwarding classes by means of *scheduler maps*. You can then associate each scheduler map with an interface, thereby configuring the hardware queues, packet schedulers, and RED processes that operate according to this mapping.

An individual device interface has multiple queues assigned to store packets temporarily before transmission. To determine the order to service the queues, the device uses a round-robin scheduling method based on priority and the queue's weighted round-robin (WRR) credits. Junos OS schedulers allow you to define the priority, bandwidth, delay buffer size, rate control status, and RED drop profiles to be applied to a particular queue for packet transmission.

You can configure *per-unit scheduling* (also called *logical interface scheduling*) to allow multiple output queues on a logical interface and to associate an output scheduler with each queue.



**NOTE:** For Juniper Network devices, when configuring the “protocol parameter” in the **drop-profile-map** statement, TCP and non-TCP values are not supported, only the value “any” is supported.

This section contains the following topics:

- [Transmit Rate on page 44](#)
- [Delay Buffer Size on page 45](#)
- [Scheduling Priority on page 46](#)
- [Shaping Rate on page 47](#)

## Transmit Rate

The transmission rate determines the traffic transmission bandwidth for each forwarding class you configure. The rate is specified in bits per second (bps). Each queue is allocated some portion of the bandwidth of the outgoing interface.

This bandwidth amount can be a fixed value, such as 1 megabit per second (Mbps), a percentage of the total available bandwidth, or the rest of the available bandwidth. You can limit the transmission bandwidth to the exact value you configure, or allow it to exceed the configured rate if additional bandwidth is available from other queues (SRX Series high-end devices do not support an exact value transmit rate). This property helps ensure that each queue receives the amount of bandwidth appropriate to its level of service.

The minimum transmit rate supported on high-speed interfaces is one-ten thousandth of the speed of that interface. For example, on a Gigabit Ethernet interface with a speed of 1,000 Mbps, the minimum transmit rate is 100 Kbps (1,000 Mbps x 1/10,000). You can configure transmit rates in the range 3,200 bps through 160,000,000,000 bps. When the configured rate is less than the minimum transmit rate, the minimum transmit rate is used instead.



**NOTE:** Interfaces with slower interface speeds, like T1, E1, or channelized T1/E1/ISDN PRI, cannot support minimum transmit rates because the minimum transmit rate supported on a services router is 3,200 bps.

Transmit rate assigns the weighted round-robin (WRR) priority values within a given priority level and not between priorities.

The transmit rate defines the transmission rate of a scheduler. The transmit rate determines the traffic bandwidth from each forwarding class you configure.

By default, queues 0 through 7 have the following percentage of transmission capacity:

- Queue 0—95 percent
- Queue 1—0 percent
- Queue 2—0 percent
- Queue 3—0 percent
- Queue 4—0 percent
- Queue 6—0 percent
- Queue 7—5 percent

To define a transmit rate, select the appropriate option:

- To specify a transmit rate, select **rate** and type an integer from 3200 to 160,000,000,000 bits per second.
- To enforce an exact transmit rate, select **rate**.
- To specify the remaining transmission capacity, select **remainder**.
- To specify a percentage of transmission capacity, select **percent** and type an integer from 1 through 100.

Optionally, you can specify the percentage of the remainder to be used for allocating the transmit rate of the scheduler on a prorated basis. If there are still points left even after allocating the remainder percentage with the transmit rate and there are no queues, then the points are allocated point by point to each queue in a round-robin method. If the remainder percentage is not specified, the remainder value will be shared equally.

## Delay Buffer Size

You can configure the delay buffer size to control congestion at the output stage. A delay buffer provides packet buffer space to absorb burst traffic up to a specified duration of delay. When the buffer is full, all packets are dropped.

The system calculates the buffer size for a queue based on the buffer allocation method you specify for it in the scheduler. By default, all J Series device interfaces other than channelized T1/E1 interfaces support a delay buffer time of 100,000 microseconds. On channelized T1/E1 interfaces, the default delay buffer time is 500,000 microseconds for clear-channel interfaces, and 1,200,000 microseconds for NxDS0 interfaces.

On Juniper Networks devices, you can configure larger delay buffers on channelized T1/E1 interfaces. Larger delay buffers help these slower interfaces to avoid congestion and packet dropping when they receive large bursts of traffic.

To define a delay buffer size for a scheduler, select the appropriate option:

- To enforce exact buffer size, select **Exact**.
- To specify a buffer size as a temporal value (microseconds), select **Temporal**.
- To specify buffer size as a percentage of the total buffer, select **Percent** and type an integer from 1 through 100.
- To specify buffer size as the remaining available buffer, select **Remainder**.

Optionally, you can specify the percentage of the remainder to be used for allocating the buffer size of the scheduler on a prorated basis.

By default, sizes of the delay buffer queues 0 through 7 have the following percentage of the total available buffer space:

- Queue 0—95 percent
- Queue 1—0 percent
- Queue 2—0 percent
- Queue 3—0 percent
- Queue 4—0 percent
- Queue 5—0 percent
- Queue 6—0 percent
- Queue 7—5 percent



**NOTE:** A large buffer size value correlates with a greater possibility of packet delays. This might not be practical for sensitive traffic such as voice or video.



**NOTE:** For a Juniper Networks device, if the buffer size percentage is set to zero for T1 interfaces, traffic does not pass.

## Scheduling Priority

Scheduling priority determines the order in which an output interface transmits traffic from the queues, thus ensuring that queues containing important traffic are provided better access to the outgoing interface.

The queues for an interface are divided into sets based on their priority. Each set contains queues of the same priority. The device examines the sets in descending order of priority. If at least one queue in a set has a packet to transmit, the device selects that set. If multiple queues in the set have packets to transmit, the device selects a queue from the set according to the weighted round-robin (WRR) algorithm that operates within the set.

The packets in a queue are transmitted based on the configured scheduling priority, the transmit rate, and the available bandwidth.

The scheduling priority of the scheduler determines the order in which an output interface transmits traffic from the queues. You can set scheduling priority at different levels in an order of increasing priority from low to high. A high-priority queue with a high transmission rate might lock out lower-priority traffic.

To specify a scheduling priority, select one of the following levels:

- **high**—Packets in this queue have high priority.
- **low**—Packets in this queue are transmitted last.
- **medium—low**—Packets in this queue have medium-low priority.
- **medium—high**—Packets in this queue have medium-high priority.
- **strict—high**—Packets in this queue are transmitted first.

## Shaping Rate

Shaping rates control the maximum rate of traffic transmitted on an interface. You can configure the shaping rate so that the interface transmits less traffic than it is physically capable of carrying.

You can configure shaping rates on logical interfaces. By default, output scheduling is not enabled on logical interfaces. Logical interface scheduling (also called per-unit scheduling) allows you to enable multiple output queues on a logical interface and associate an output scheduler and shaping rate with the queues.

By default, the logical interface bandwidth is the average of unused bandwidth for the number of logical interfaces that require default bandwidth treatment. You can specify a peak bandwidth rate in bits per second (bps), either as a complete decimal number or as a decimal number followed by the abbreviation *k* (1,000), *m* (1,000,000), or *g* (1,000,000,000). The range is from 1,000 through 32,000,000,000 bps.

For low-speed interfaces, the queue-limit values might become lower than the interface MTU so that traffic with large packets can no longer pass through some of the queues. If you want larger-sized packets to flow through, set the buffer-size configuration in the scheduler to a larger value. For more accuracy, the 100-ms queue-limit values are calculated based on shaper rates and not on interface rates.

The shaping rate defines the minimum bandwidth allocated to a queue. The default shaping rate is 100 percent, which is the same as no shaping at all. To define a shaping rate, select the appropriate option:

- To specify shaping rate as an absolute number of bits per second, select **rate** and type an integer from 3,200 to 160,000,000,000 bits per second.
- To specify shaping rate as a percentage, select **percent** and type an integer from 0 through 100.

### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Default Scheduler Settings on page 48](#)
- [Example: Configuring Class-of-Service Schedulers on page 49](#)
- [Scheduler Buffer Size Overview on page 53](#)
- [Example: Configuring a Large Delay Buffer on a Channelized T1 Interface on page 55](#)
- [Example: Configuring and Applying Scheduler Maps on page 63](#)
- [Transmission Scheduling Overview on page 65](#)

## Default Scheduler Settings

---

Each forwarding class has an associated scheduler priority. Only two forwarding classes, best-effort and network-control (queue 0 and queue 3), are used in the Junos OS default scheduler configuration.

By default, the best-effort forwarding class (queue 0) receives 95 percent, and the network-control (queue 3) receives 5 percent of the bandwidth and buffer space for the output link. The default drop profile causes the buffer to fill and then discard all packets until it again has space.

The expedited-forwarding and assured-forwarding classes have no schedulers, because by default no resources are assigned to queue 1 and queue 2. However, you can manually configure resources for the expedited-forwarding and the assured-forwarding classes.

By default, each queue can exceed the assigned bandwidth if additional bandwidth is available from other queues. When a forwarding class does not fully use the allocated transmission bandwidth, the remaining bandwidth can be used by other forwarding classes if they receive a larger amount of offered load than the bandwidth allocated. If you do not want a queue to use any leftover bandwidth, you must configure it for strict allocation.

The device uses the following default scheduler settings. You can configure these settings.

```
[edit class-of-service]
schedulers {
  network-control {
    transmit-rate percent 5;
    buffer-size percent 5;
    priority low;
    drop-profile-map loss-priority any protocol any drop-profile terminal;
  }
  best-effort {
    transmit-rate percent 95;
    buffer-size percent 95;
    priority low;
    drop-profile-map loss-priority any protocol any drop-profile terminal;
  }
}
drop-profiles {
  terminal {
    fill-level 100 drop-probability 100;
  }
}
```

### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Schedulers Overview on page 43](#)
- [Example: Configuring Class-of-Service Schedulers on page 49](#)
- [Scheduler Buffer Size Overview on page 53](#)
- [Example: Configuring a Large Delay Buffer on a Channelized T1 Interface on page 55](#)



- [Example: Configuring and Applying Scheduler Maps on page 63](#)
- [Transmission Scheduling Overview on page 65](#)

## Example: Configuring Class-of-Service Schedulers

---

This example shows how to configure CoS schedulers on a device.

- [Requirements on page 49](#)
- [Overview on page 49](#)
- [Configuration on page 50](#)
- [Verification on page 52](#)

### Requirements

Before you begin, determine the buffer size allocation method to use. See [“Scheduler Buffer Size Overview” on page 53](#).

### Overview

An individual device interface has multiple queues assigned to store packets temporarily before transmission. To determine the order in which to service the queues, the device uses a round-robin scheduling method based on priority and the queue's weighted round-robin (WRR) credits. Junos OS schedulers allow you to define the priority, bandwidth, delay buffer size, rate control status, and RED drop profiles to be applied to a particular queue for packet transmission.

You configure schedulers to assign resources, priorities, and drop profiles to output queues. By default, only queues 0 and 3 have resources assigned.



**NOTE:** Juniper Network devices support hierarchical schedulers, including per-unit schedulers.

---

In this example, you configure a best-effort scheduler called be-scheduler. You set the priority as low and the buffer size to 40. You set the be-scheduler transmit-rate remainder percentage to 40. You configure an expedited forwarding scheduler called ef-scheduler and set the priority as high and the buffer size to 10. You set the ef-scheduler transmit-rate remainder percentage to 50.

Then you configure an assured forwarding scheduler called af-scheduler and set the priority as high and buffer size to 45. You set an assured forwarding scheduler transmit rate to 45. You then configure a drop profile map for assured forwarding as low and high priority. (DiffServ can have a RED drop profile associated with assured forwarding.)

Finally, you configure a network control scheduler called nc-scheduler and set the priority as low and buffer size to 5. You set a network control scheduler transmit rate to 5.

[Table 14 on page 50](#) shows the schedulers created in this example.

Table 14: Sample Schedulers

Scheduler	For CoS Traffic Type	Assigned Priority	Allocated Portion of Queue Buffer	Allocated Portion of Remainder (Transmit Rate)
be-scheduler	Best-effort traffic	Low	40 percent	40 percent
ef-scheduler	Expedited forwarding traffic	High	10 percent	50 percent
af-scheduler	Assured forwarding traffic	High	45 percent	—
nc-scheduler	Network control traffic	Low	5 percent	—

## Configuration

**CLI Quick Configuration** To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service schedulers be-scheduler priority low buffer-size percent 40
set class-of-service schedulers be-scheduler transmit-rate remainder 40
set class-of-service schedulers ef-scheduler priority high buffer-size percent 10
set class-of-service schedulers ef-scheduler transmit-rate remainder 50
set class-of-service schedulers af-scheduler priority high buffer-size percent 45
set class-of-service schedulers af-scheduler transmit-rate percent 45
set class-of-service schedulers af-scheduler drop-profile-map loss-priority low protocol
any drop-profile af-normal
set class-of-service schedulers af-scheduler drop-profile-map loss-priority high protocol
any drop-profile af-with-PLP
set class-of-service schedulers nc-scheduler priority low buffer-size percent 5
set class-of-service schedulers nc-scheduler transmit-rate percent 5
```

**Step-by-Step Procedure** The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see [Using the CLI Editor in Configuration Mode](#) in the *Junos OS CLI User Guide*.

To configure CoS schedulers:

1. Configure a best-effort scheduler.  

```
[edit]
user@host# edit class-of-service schedulers be-scheduler
```
2. Specify a best-effort scheduler priority and buffer size.  

```
[edit class-of-service schedulers be-scheduler]
user@host# set priority low
user@host# set buffer-size percent 40
```
3. Configure a remainder option for a best-effort scheduler transmit rate.  

```
[edit class-of-service schedulers be-scheduler]
```

- ```
user@host# set transmit-rate remainder 40
```
4. Configure an expedited forwarding scheduler.  

```
[edit]  
user@host# edit class-of-service schedulers ef-scheduler
```
  5. Specify an expedited forwarding scheduler priority and buffer size.  

```
[edit class-of-service schedulers ef-scheduler]  
user@host# set priority high  
user@host# set buffer-size percent 10
```
  6. Configure a remainder option for an expedited forwarding scheduler transmit rate.  

```
[edit class-of-service schedulers ef-scheduler]  
user@host# set transmit-rate remainder 50
```
  7. Configure an assured forwarding scheduler.  

```
[edit]  
user@host# edit class-of-service schedulers af-scheduler
```
  8. Specify an assured forwarding scheduler priority and buffer size.  

```
[edit class-of-service schedulers af-scheduler]  
user@host# set priority high  
user@host# set buffer-size percent 45
```
  9. Configure an assured forwarding scheduler transmit rate.  

```
[edit class-of-service schedulers af-scheduler]  
user@host# set transmit-rate percent 45
```
  10. Configure a drop profile map for assured forwarding low and high priority.  

```
[edit class-of-service schedulers af-scheduler]  
user@host# set drop-profile-map loss-priority low protocol any drop-profile  
af-normal  
user@host# set drop-profile-map loss-priority high protocol any drop-profile  
af-with-PLP
```
  11. Configure a network control scheduler.  

```
[edit]  
user@host# edit class-of-service schedulers nc-scheduler
```
  12. Specify a network control scheduler priority and buffer size.  

```
[edit class-of-service schedulers nc-scheduler]  
user@host# set priority low  
user@host# set buffer-size percent 5
```
  13. Configure a network control scheduler transmit rate.  

```
[edit class-of-service schedulers nc-scheduler]  
user@host# set transmit-rate percent 5
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
```

```
user@host# show class-of-service
schedulers {
  be-scheduler {
    transmit-rate remainder 40;
    buffer-size percent 40;
    priority low;
  }
  ef-scheduler {
    transmit-rate remainder 50;
    buffer-size percent 10;
    priority high;
  }
  af-scheduler {
    transmit-rate percent 45;
    buffer-size percent 45;
    priority high;
    drop-profile-map loss-priority low protocol any drop-profile af-normal;
    drop-profile-map loss-priority high protocol any drop-profile af-with-PLP;
  }
  nc-scheduler {
    transmit-rate percent 5;
    buffer-size percent 5;
    priority low;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

Confirm that the configuration is working properly.

- [Verifying Schedulers Configuration on page 52](#)

---

### Verifying Schedulers Configuration

**Purpose** Verify that the schedulers are configured properly.

**Action** From operational mode, enter the **show class-of-service** command.

**Related Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Schedulers Overview on page 43](#)
- [Default Scheduler Settings on page 48](#)
- [Example: Configuring a Large Delay Buffer on a Channelized T1 Interface on page 55](#)
- [Example: Configuring and Applying Scheduler Maps on page 63](#)
- [Transmission Scheduling Overview on page 65](#)

## Scheduler Buffer Size Overview

Large bursts of traffic from faster interfaces can cause congestion and dropped packets on slower interfaces that have small delay buffers. For example, a Juniper Networks device operating at the edge of the network can drop a portion of the burst traffic it receives on a channelized T1/E1 interface from a Fast Ethernet or Gigabit Ethernet interface on a router at the network core. On Juniper Networks devices, large delay buffers can be configured for both channelized T1/E1 and nonchannelized T1/E1 interfaces.

To ensure that traffic is queued and transmitted properly on slower interfaces, you can configure a buffer size larger than the default maximum.

This section contains the following topics:

- [Maximum Delay Buffer Sizes Available to Channelized T1/E1 Interfaces on page 53](#)
- [Delay Buffer Size Allocation Methods on page 54](#)
- [Delay Buffer Sizes for Queues on page 54](#)

### Maximum Delay Buffer Sizes Available to Channelized T1/E1 Interfaces

When you enable the large delay buffer feature on interfaces, a larger buffer is available for allocation to scheduler queues. The maximum delay buffer size that is available for an interface depends on the maximum available delay buffer time and the speed of the interface as shown in [Table 15 on page 53](#).

The default values are as follows:

- Clear-channel interface—The default delay buffer time is 500,000 microseconds (0.5 s).
- NxDS0 interface—The default delay buffer time is 1,200,000 microseconds (1.2 s).

**Table 15: Maximum Available Delay Buffer Time by Channelized Interface and Rate**

| Effective Line Rate | Maximum Available Delay Buffer Time |
|---------------------|-------------------------------------|
| < 4xDS0             | 4,000,000 microseconds (4 s)        |
| < 8xDS0             | 2,000,000 microseconds (2 s)        |
| < 16xDS0            | 1,000,000 microseconds (1s)         |
| <= 32xDS0           | 500,000 microseconds (0.5 s)        |
| <= 10 mbps          | 400,000 microseconds (0.4 s)        |
| <= 20 mbps          | 300,000 microseconds (0.3 s)        |
| <= 30 mbps          | 200,000 microseconds (0.2 s)        |
| <= 40 mbps          | 150,000 microseconds (0.15 s)       |

You can calculate the maximum delay buffer size available for an interface, with the following formula:

$$\text{interface speed} \times \text{maximum delay buffer time} = \text{maximum available delay buffer size}$$

For example, the following maximum delay buffer sizes are available to 1xDSO and 2xDSO interfaces:

**1xDSO**—64 Kbps x 4 s = 256 Kb (32 KB)

**2xDSO**—128 Kbps x 4 s = 512 Kb (64 KB)

If you configure a delay buffer size larger than the new maximum, the system allows you to commit the configuration but displays a system log warning message and uses the default buffer size setting instead of the configured maximum setting.

## Delay Buffer Size Allocation Methods

You can specify delay buffer sizes for each queue using schedulers. The queue buffer can be specified as a period of time (microseconds) or as a percentage of the total buffer or as the remaining buffer. [Table 16 on page 54](#) shows different methods that you can specify for buffer allocation in queues.

**Table 16: Delay Buffer Size Allocation Methods**

| Buffer Size Allocation Method | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Percentage                    | A percentage of the total buffer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Temporal                      | <p>A period of time, value in microseconds. When you configure a temporal buffer, you must also configure a transmit rate. The system calculates the queue buffer size by multiplying the available bandwidth of the interface times the configured temporal value and transmit rate.</p> <p>When you specify a temporal method, the drop profile is assigned a static buffer and the system starts dropping packets once the queue buffer size is full. By default, the other buffer types are assigned dynamic buffers that use surplus transmission bandwidth to absorb bursts of traffic.</p>     |
| Remainder                     | <p>The remaining buffer available. The remainder is the percentage buffer that is not assigned to other queues. For example, if you assign 40 percent of the delay buffer to queue 0, allow queue 3 to keep the default allotment of 5 percent, and assign the remainder to queue 7, then queue 7 uses approximately 55 percent of the delay buffer.</p> <p>Optionally, you can specify the percentage of the remainder to be used for allocating the buffer size of the scheduler on a prorated basis. If the remainder percentage is not specified, the remainder value will be shared equally.</p> |

## Delay Buffer Sizes for Queues

You specify delay buffer sizes for queues using schedulers. The system calculates the buffer size of a queue based on the buffer allocation method you specify for it in the scheduler. See [Table 16 on page 54](#) for different buffer allocation methods and [Table 17 on page 55](#) for buffer size calculations.

Table 17: Delay Buffer Allocation Method and Queue Buffer

| Buffer Size Allocation Method | Queue Buffer Calculation                                                                                                    | Example                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Percentage                    | <i>available interface bandwidth × configured buffer size percentage × maximum delay buffer time = queue buffer</i>         | <p>Suppose you configure a queue on a 1xDS0 interface to use 30 percent of the available delay buffer size. The system uses the maximum available delay buffer time (4 seconds) and allocates the queue 9600 bytes of delay buffer:</p> <p>64 Kbps × 0.3 × 4 s = 76,800 bits = 9,600 bytes</p>                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Temporal                      | <i>available interface bandwidth × configured transmit rate percentage × configured temporal buffer size = queue buffer</i> | <p>Suppose you configure a queue on a 1xDS0 interface to use 300,000 microseconds (3 seconds) of delay buffer, and you configure the transmission rate to be 20 percent. The queue receives 4800 bytes of delay buffer:</p> <p>64 Kbps × 0.2 × 3 s = 38,400 bits = 4,800 bytes</p> <p>When you configure a temporal value that is greater than the maximum available delay buffer time, the system allocates this queue the remaining buffer after other queues are allocated buffer. Suppose you configure a temporal value of 6,000,000 microseconds on a 1xDS0 interface. Because this value is greater than the maximum allowed value of 4,000,000 microseconds, the queue is allocated the remaining delay buffer.</p> |

When you specify the buffer size as a percentage, the system ignores the transmit rate and calculates the buffer size based only on the buffer size percentage.

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Schedulers Overview on page 43](#)
- [Default Scheduler Settings on page 48](#)
- [Example: Configuring Class-of-Service Schedulers on page 49](#)
- [Example: Configuring a Large Delay Buffer on a Channelized T1 Interface on page 55](#)
- [Example: Configuring and Applying Scheduler Maps on page 63](#)
- [Transmission Scheduling Overview on page 65](#)

### Example: Configuring a Large Delay Buffer on a Channelized T1 Interface

This example shows how to configure a large delay buffer on a channelized T1 interface to help slower interfaces avoid congestion and packet dropping when they receive large bursts of traffic.

- [Requirements on page 56](#)
- [Overview on page 56](#)

- [Configuration on page 56](#)
- [Verification on page 58](#)

## Requirements

Before you begin, enable the large buffer feature on the channelized T1/E1 PIM and then configure a buffer size for each queue in the CoS scheduler. See “[Scheduler Buffer Size Overview](#)” on page 53.

## Overview

On devices, you can configure large delay buffers on channelized T1/E1 interfaces. Each channelized T1/E1 interface can be configured as a single clear channel, or for channelized (NxDSO) operation, where N denotes channels 1 to 24 for a T1 interface and channels 1 to 32 for an E1 interface.

In this example, you specify a queue buffer of 30 percent in scheduler **be-scheduler** and associate the scheduler to a defined forwarding class **be-class** using scheduler map **large-buf-sched-map**. Finally, you apply the scheduler map to channelized T1 interface **t1-3/0/0**.

## Configuration

### CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set chassis fpc 3 pic 0 q-pic-large-buffer
set class-of-service schedulers be-scheduler buffer-size percent 30
set class-of-service scheduler-maps large-buf-sched-map forwarding-class be-class
scheduler be-scheduler
set class-of-service interfaces t1-3/0/0 unit 0 scheduler-map large-buf-sched-map
```

### Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see [Using the CLI Editor in Configuration Mode](#) in the *Junos OS CLI User Guide*.

To configure a large delay buffer on a channelized T1 interface:

1. Enable the large buffer size feature on the channelized T1 interface.  

```
[edit]
user@host# edit chassis
user@host# set fpc 3 pic 0 q-pic-large-buffer
```
2. Create Best-effort traffic and specify a buffer size.  

```
[edit]
user@host# edit class-of-service
user@host# set schedulers be-scheduler buffer-size percent 30
```
3. Configure the scheduler map to associate schedulers with defined forwarding classes.  

```
[edit class-of-service]
```



```
user@host# set scheduler-maps large-buf-sched-map forwarding-class be-class
scheduler be-scheduler
```

4. Apply the scheduler map to the channelized T1 interface.

```
[edit class-of-service]
user@host# set interfaces t1-3/0/0 unit 0 scheduler-map large-buf-sched-map
```



**NOTE:** The `q-pic-large-buffer` can be used for all interfaces (channelized and non-channelized) on J Series devices. This command will be in effect when the interface speed is less than 2 Mbps. For example, on a Gigabit Ethernet interface with shaping rate of 512 Kbps, if `q-pic-large-buffer` parameter is configured, then the available buffering will be increased similar to the buffer available for channelized PIMs.

**Results** From configuration mode, confirm your configuration by entering the `show class-of-service` and `show chassis` commands. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service
interfaces {
  t1-3/0/0 {
    unit 0 {
      scheduler-map large-buf-sched-map;
    }
  }
}
scheduler-maps {
  large-buf-sched-map {
    forwarding-class be-class scheduler be-scheduler;
  }
}
schedulers {
  be-scheduler {
    buffer-size percent 30;
  }
}
[edit]
user@host# show chassis
fpc 3 {
  pic 0 {
    q-pic-large-buffer;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

Confirm that the configuration is working properly.

- [Verifying Large Delay Buffers Configuration on page 58](#)

---

### Verifying Large Delay Buffers Configuration

**Purpose** Verify that the large delay buffers are configured properly.

**Action** From configuration mode, enter the **show class-of-service** and **show chassis** commands.

- Related Documentation**
- [Junos OS Interfaces Configuration Guide for Security Devices](#)
  - [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
  - [Schedulers Overview on page 43](#)
  - [Default Scheduler Settings on page 48](#)
  - [Example: Configuring Class-of-Service Schedulers on page 49](#)
  - [Example: Configuring and Applying Scheduler Maps on page 63](#)
  - [Transmission Scheduling Overview on page 65](#)

---

## Configuring Large Delay Buffers in CoS

You can configure very large delay buffers using the **buffer-size-temporal** command combined with the **q-pic-large-buffer** command. The **buffer-size temporal** option in combination with **q-pic-large-buffer** can create extra-large delay buffer allocations for one or several queues on an interface.

### Configuring Large Delay Buffers

The following configuration applies to the examples that follow:

1. Configure two VLANs (one ingress, one egress) on one interface. No interface shaping rate is initially defined for this configuration.

```
[edit]
set interfaces ge-0/0/3 per-unit-scheduler
set interfaces ge-0/0/3 vlan-tagging
set interfaces ge-0/0/3 unit 102 vlan-id 102
set interfaces ge-0/0/3 unit 102 family inet address 1.1.102.2/24
set interfaces ge-0/0/3 unit 201 vlan-id 201
set interfaces ge-0/0/3 unit 201 family inet address 2.2.201.2/24
set routing-options static route 33.33.1.1/32 next-hop 2.2.201.3
```

2. Enable the **q-pic-large-buffer** option on the same PIC, in addition to the **buffer-size temporal** option on the queue, to create a large buffer on the queue:

```
[edit]
set chassis fpc 0 pic 0 q-pic-large-buffer
```



**NOTE:** The CLI does not provide a warning when you use **buffer-size temporal** without **q-pic-large-buffer**. When you use **buffer-size temporal**, verify that the configuration also includes the **q-pic-large buffer** command.

3. Define four forwarding-classes (queue names) for the four queues:

```
[edit]
set class-of-service forwarding-classes queue 0 be-Queue0
set class-of-service forwarding-classes queue 1 video-Queue1
set class-of-service forwarding-classes queue 2 voice-Queue2
set class-of-service forwarding-classes queue 3 nc-Queue3
```

4. Configure the forwarding classes (queue names) included in a scheduler map, applied to the egress VLAN:

```
[edit]
set class-of-service interfaces ge-0/0/3 unit 201 scheduler-map schedMapM
set class-of-service scheduler-maps schedMapM forwarding-class be-Queue0
  scheduler be-Scheduler0
set class-of-service scheduler-maps schedMapM forwarding-class video-Queue1
  scheduler video-Scheduler1
set class-of-service scheduler-maps schedMapM forwarding-class voice-Queue2
  scheduler voice-Scheduler2
set class-of-service scheduler-maps schedMapM forwarding-class nc-Queue3
  scheduler nc-Scheduler3
```

5. Set the queue priorities. Only queue priorities are initially defined, not transmit rates or buffer sizes.

```
[edit]
set class-of-service schedulers be-Scheduler0 priority low
set class-of-service schedulers video-Scheduler1 priority medium-low
set class-of-service schedulers voice-Scheduler2 priority medium-high
set class-of-service schedulers nc-Scheduler3 priority high
```

#### Example: Simple Configuration Using Four Queues

This configuration allocates 12,500,000 bytes of buffer for each of the four queues. To avoid exceeding the limits of the delay buffer calculation, this initial example has no interface shaping rate, scheduler transmit rate, or scheduler buffer size percent configuration.

1. Specify the maximum 4-second delay buffer on each of the four queues:

```
[edit]
set class-of-service schedulers be-Scheduler0 buffer-size temporal 4m
set class-of-service schedulers video-Scheduler1 buffer-size temporal 4m
set class-of-service schedulers voice-Scheduler2 buffer-size temporal 4m
set class-of-service schedulers nc-Scheduler3 buffer-size temporal 4m
```

Specifying **buffer-size temporal** on some or all queues uses implicit (default) or explicit transmit rate percentages as the buffer-size percentages of the temporal values for those queues. Because there are no explicitly specified transmit rate percentages, divide 100 percent by the number of configured queues (queues with schedulers

configured in the scheduler map) to get the implicit (default) per-queue transmit rate percentages. Each queue gets an implicit (default) transmit rate of  $100\% / 4 = 25\%$ .

In this example, specifying the maximum 4-second delay on each queue, with no shaping rate on the interface and implicit (default) per-queue transmit rates of 25 percent, the total buffer for all temporal 4m queues on an interface = 4 seconds \* 100,000,000 maximum interface bps / 8 bits/byte = 4 seconds \* 12,500,000 bytes = 50,000,000 bytes. Each queue specifying temporal 4m gets  $25\% * 50,000,000 = 12,500,000$  bytes.

2. Add a shaping rate of 4 Mbps to the interface:

```
[edit]
set class-of-service interfaces ge-0/0/3 unit 201 shaping-rate 4m
```

The total buffer for all temporal 4m queues on an interface = 4 sec \* 4,000,000 bps shaping-rate / 8 bits/byte = 4 sec \* 500,000 bytes = 2,000,000 bytes. Therefore, each queue specifying temporal 4m receives  $25\% * 2,000,000 = 500,000$  bytes.

When using **buffer-size temporal** on any interface queues, if you also use the **transmit-rate percent** command, or the **buffer-size percent** command, or both commands, on any of the interface queues, the buffer size calculations become more complex and the limits of available queue depth may be reached. If the configuration attempts to exceed the available memory, then at commit time two system log messages appear in the `/var/log/messages` file, the interface class-of-service configuration is ignored, and the interface class-of-service configuration reverts to the two-queue defaults:

```
Mar 11 11:02:10.239 elma-n4 elma-n4 COSMAN_FWDD: queue mem underflow for ge-0/0/3
Mar 11 11:02:10.240 elma-n4 elma-n4 cosman_compute_install_sched_params: Failed
to compute scheduler params for ge-0/0/3.Hence retaining defaults
```

When configuring **buffer-size temporal** along with **transmit-rate percent** or **buffer-size percent**, or both, you must monitor the system log to see whether the available queue depth limit has been reached.

#### Example: Using **buffer-size temporal** with Explicit **transmit-rate percent** Commands

To add explicit transmit rates to all four queues:

```
[edit]
set class-of-service schedulers be-Scheduler0 transmit-rate percent 10
set class-of-service schedulers video-Scheduler1 transmit-rate percent 25
set class-of-service schedulers voice-Scheduler2 transmit-rate percent 25
set class-of-service schedulers nc-Scheduler3 transmit-rate percent 40
```

For example, if an interface is shaped to 4Mbps, the transmit rate percentage of 10 for a queue means that the bandwidth share for the specific queue is 0.4 Mbps. The queues are allocated portions of the 2,000,000 bytes of total buffer available for temporal queues on this interface, proportionally to their transmit rates. The four queues get 200,000, 500,000, 500,000, and 800,000 bytes of delay buffer, respectively.

To avoid exceeding the queue depth limits and triggering system log messages and default configuration behavior, when configuring queues with **buffer-size temporal** and **transmit rate percent** and other (non-temporal) queues with **buffer-size percent**, the

following configuration rule must be followed: When one or more queues on an interface are configured with **buffer-size temporal**, the sum of the temporal queues explicitly configured transmit rate percentages plus other non-temporal queues explicitly configured buffer size percentages must not exceed 100 percent.

If the total of the temporal queues transmit rate percentages and the non-temporal queues buffer-size percentages exceeds 100 percent, the **queue mem underflow** and **Failed to compute scheduler params** system log messages appear in the messages log, the explicitly configured CLI CoS configuration for the interface is ignored, and the interface reverts to a two-queue default CoS configuration.

When **buffer-size temporal** is specified on a queue, if **transmit-rate percent** is also configured on the same queue, the queue depth configured is based on the fractional bandwidth for the queue as obtained by the specified **transmit-rate percent**.

In addition to temporal delay times specified for one or more queues using buffer size temporal, there is another delay time automatically computed for the entire interface. This interface delay time is distributed across all non-temporal queues, proportionally to their implicit (default) or explicit transmit-rate percentages. If **q-pic-large-buffer** is not enabled, the interface delay time defaults to 100 ms. As shown in Table 18, when **q-pic-large-buffer** is enabled, interface delay time is calculated according to configured shaping rate for the interface. Because the shaping-rate configured in the example above was 4 Mbps (> 2,048,000 bps), the interface delay time for the configuration is 100 msec.

**Table 18: Interface Delay Times Enabled By q-pic-large-buffer**

| Configured Shaping Rate (bps) | Interface Delay Time (msec) Used for Non-Temporal Queues with q-pic-large-buffer Enabled | Default Delay Time Used (msec) Without q-pic-large-buffer |
|-------------------------------|------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| 64,000-255,999                | 4000                                                                                     | 100                                                       |
| 256,000 - 511,999             | 2000                                                                                     | 100                                                       |
| 512,000 - 102,3999            | 1000                                                                                     | 100                                                       |
| 1,024,000 - 2,047,999         | 500                                                                                      | 100                                                       |
| >= 2,048,000                  | 100                                                                                      | 100                                                       |

This example properly computes the delay buffer limits on both temporal and non-temporal queues:

1. Substitute **buffer-size percent** for **buffer-size temporal** on queues 0 and 1:

```
[edit]
delete class-of-service schedulers be-Scheduler0 buffer-size temporal 4m
delete class-of-service schedulers video-Scheduler1 buffer-size temporal 4m
set class-of-service schedulers be-Scheduler0 buffer-size percent 10
set class-of-service schedulers video-Scheduler1 buffer-size percent 25
```

This deletes the requirement for hard-specified 4 seconds of buffering and replaces it with a proportional limit of 10 percent (or 25 percent) of the total interface delay time for the non-temporal queues. In both cases, the queue depth is calculated based on the share of the interface bandwidth for the specific queues. Total Interface Non-Temporal Queue Memory = shaping-rate \* Interface delay time (Table 1) = 4 Mbps \* 0.1 seconds = 500,000 bytes per second \* 0.1 seconds = 50,000 bytes, therefore queues 0 and 1 get 10% \* 50,000 = 5000 bytes and 25% \* 50,000 = 12,500 bytes of delay buffer, respectively.

2. Configure **buffer-size temporal** on queues 2 and 3:

```
[edit]
set class-of-service schedulers voice-Scheduler2 buffer-size temporal 4m
set class-of-service schedulers voice-Scheduler2 transmit-rate percent 25
set class-of-service schedulers nc-Scheduler3 buffer-size temporal 4m
set class-of-service schedulers nc-Scheduler3 transmit-rate percent 40
```

Queues 2 and 3 still get 500,000 and 800,000 bytes of delay buffer, respectively, as previously calculated. This configuration obeys the rule that the sum of the temporal queues transmit rate percentages (25% + 40% = 65%), plus the non-temporal queues buffer size percentages (10% + 25% = 35%) do not exceed 100% (65% + 35% <= 100%).

The following example exceeds the delay buffer limit, triggering the system log messages and the default, two-queue class-of-service behavior.

Increase the buffer-size percentage from 25 percent to 26 percent for non-temporal queue 1:

```
[edit]
set class-of-service schedulers video-Scheduler1 buffer-size percent 26
```

This violates the configuration rule that the sum of the non-temporal queues buffer-size percentages (10% + 26% = 36%), plus the temporal queues transmit rate percentages (25% + 40% = 65%) now exceed 100% (36% + 65% = 101%). Therefore, the following two system log messages appear in the `/var/log/messages` file:

```
Mar 23 18:08:23 e1ma-n4 e1ma-n4 COSMAN_FWDD: %PFE-3: queue mem underflow for
ge-0/0/3 q_num(3)
Mar 23 18:08:23 e1ma-n4 e1ma-n4 cosman_compute_install_sched_params: %PFE-3:
Failed to compute scheduler params for ge-0/0/3.Hence retaining defaults
```

When the delay buffer limits are exceeded, the CLI-configured class-of-service settings are not used and the default class-of-service configuration (the default scheduler-map) is assigned to the interface. This uses two queues: the forwarding-class best-effort (queue 0) has transmit rate percent 95 and buffer-size percent 95 and the forwarding-class network-control (queue 3) has the transmit rate percent 5 and buffer-size percent 5.

```
queue 0: 1,187,500 Bytes
queue 1:    9,192 Bytes
queue 2:    9,192 Bytes
queue 3:   62,500 Bytes
```

## Example: Configuring and Applying Scheduler Maps

This example shows how to configure and apply a scheduler map to a device's interface.

- [Requirements on page 63](#)
- [Overview on page 63](#)
- [Configuration on page 63](#)
- [Verification on page 65](#)

### Requirements

Before you begin:

- Create and configure the forwarding classes. See [Configuring Forwarding Classes](#).
- Create and configure the schedulers. See [“Example: Configuring Class-of-Service Schedulers” on page 49](#).

### Overview

After you define a scheduler, you can include it in a scheduler map, which maps a specified forwarding class to a scheduler configuration. You configure a scheduler map to assign a forwarding class to a scheduler, and then apply the scheduler map to any interface that must enforce DiffServ CoS.

After they are applied to an interface, the scheduler maps affect the hardware queues, packet schedulers, and RED drop profiles.

In this example, you create the scheduler map `diffserv-cos-map` and apply it to the device's Ethernet interface `ge-0/0/0`. The map associates the `mf-classifier` forwarding classes to the schedulers as shown in [Table 19 on page 63](#).

**Table 19: Sample `diffserv-cos-map` Scheduler Mapping**

| mf-classifier Forwarding Class | For CoS Traffic Type         | diffserv-cos-map Scheduler |
|--------------------------------|------------------------------|----------------------------|
| be-class                       | Best-effort traffic          | be-scheduler               |
| ef-class                       | Expedited forwarding traffic | ef-scheduler               |
| af-class                       | Assured forwarding traffic   | af-scheduler               |
| nc-class                       | Network control traffic      | nc-scheduler               |

### Configuration

**CLI Quick Configuration** To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```

set class-of-service scheduler-maps diffserv-cos-map forwarding-class be-class scheduler
  be-scheduler
set class-of-service scheduler-maps diffserv-cos-map forwarding-class ef-class scheduler
  ef-scheduler
set class-of-service scheduler-maps diffserv-cos-map forwarding-class af-class scheduler
  af-scheduler
set class-of-service scheduler-maps diffserv-cos-map forwarding-class nc-class scheduler
  nc-scheduler
set class-of-service interfaces ge-0/0/0 unit 0 scheduler-map diffserv-cos-map

```

### Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see *Using the CLI Editor in Configuration Mode* in the [Junos OS CLI User Guide](#).

To configure and apply a scheduler map to a device's interface:

1. Configure a scheduler map for DiffServ CoS.  

```

[edit class-of-service]
user@host# edit scheduler-maps diffserv-cos-map

```
2. Configure a best-effort forwarding class and scheduler.  

```

[edit class-of-service scheduler-maps diffserv-cos-map]
user@host# set forwarding-class be-class scheduler be-scheduler

```
3. Configure an expedited forwarding class and scheduler.  

```

[edit class-of-service scheduler-maps diffserv-cos-map]
user@host# set forwarding-class ef-class scheduler ef-scheduler

```
4. Configure an assured forwarding class and scheduler.  

```

[edit class-of-service scheduler-maps diffserv-cos-map]
user@host# set forwarding-class af-class scheduler af-scheduler

```
5. Configure a network control class and scheduler.  

```

[edit class-of-service scheduler-maps diffserv-cos-map]
user@host# set forwarding-class nc-class scheduler nc-scheduler

```
6. Apply the scheduler map to an interface.  

```

[edit class-of-service]
user@host# set interfaces ge-0/0/0 unit 0 scheduler-map diffserv-cos-map

```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```

[edit]
user@host# show class-of-service
interfaces {
  ge-0/0/0 {
    unit 0 {
      scheduler-map diffserv-cos-map;
    }
  }
}

```



```
scheduler-maps {
  diffserv-cos-map {
    forwarding-class be-class scheduler be-scheduler;
    forwarding-class ef-class scheduler ef-scheduler;
    forwarding-class af-class scheduler af-scheduler;
    forwarding-class nc-class scheduler nc-scheduler;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

Confirm that the configuration is working properly.

- [Verifying the Scheduler Map Configuration on page 65](#)

---

### Verifying the Scheduler Map Configuration

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>               | Verify that scheduler maps are configured properly.                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Action</b>                | From operational mode, enter the <b>show class-of-service</b> command.                                                                                                                                                                                                                                                                                                                                                         |
| <b>Related Documentation</b> | <ul style="list-style-type: none"><li>• <a href="#">Junos OS Interfaces Configuration Guide for Security Devices</a></li><li>• <a href="#">Junos OS Feature Support Reference for SRX Series and J Series Devices</a></li><li>• <a href="#">Schedulers Overview on page 43</a></li><li>• <a href="#">Default Scheduler Settings on page 48</a></li><li>• <a href="#">Transmission Scheduling Overview on page 65</a></li></ul> |

---

## Transmission Scheduling Overview

The packets in a queue are transmitted based on their transmission priority, transmit rate, and the available bandwidth.

By default, each queue can exceed the assigned bandwidth if additional bandwidth is available from other queues. When a forwarding class does not fully use the allocated transmission bandwidth, the remaining bandwidth can be used by other forwarding classes if they receive a larger amount of offered load than the bandwidth allocated. A queue receiving traffic within its bandwidth configuration is considered to have positive bandwidth credit, and a queue receiving traffic in excess of its bandwidth allocation is considered to have negative bandwidth credit.

A queue with positive credit does not need to use leftover bandwidth, because it can use its own allocation. For such queues, packets are transmitted based on the priority of the queue, with packets from higher-priority queues transmitting first. The transmit rate is not considered during transmission. In contrast, a queue with negative credit needs a share of the available leftover bandwidth.

The leftover bandwidth is allocated to queues with negative credit in proportion to the configured transmit rate of the queues within a given priority set. The queues for an interface are divided into sets based on their priority. If no transmit rate is configured, each queue in the set receives an equal percentage of the leftover bandwidth. However, if a transmit rate is configured, each queue in the set receives the configured percentage of the leftover bandwidth.

Table 20 on page 66 shows a sample configuration of priority and transmit rate on six queues. The total available bandwidth on the interface is 100 Mbps.

**Table 20: Sample Transmission Scheduling**

| Queue | Scheduling Priority | Transmit Rate               | Incoming Traffic |
|-------|---------------------|-----------------------------|------------------|
| 0     | Low                 | 10%                         | 20 Mbps          |
| 1     | High                | 20%                         | 20 Mbps          |
| 2     | High                | 30%                         | 20 Mbps          |
| 3     | Low                 | 30%                         | 20 Mbps          |
| 4     | Medium-high         | No transmit rate configured | 10 Mbps          |
| 5     | Medium-high         | No transmit rate configured | 20 Mbps          |

In this example, queues are divided into three sets based on their priority:

- High priority set—Consists of queue 1 and queue 2. Packets use 40 Mbps (20+20) of the available bandwidth (100 Mbps) and are transmitted first. Because of positive credit, the configured transmit rate is not considered.
- Medium-high priority set—Consists of queue 4 and queue 5. Packets use 30 Mbps (10+20) of the remaining 60 Mbps bandwidth. Because of positive credit, the transmit rate is not considered. If the queues had negative credit, they would receive an equal share of the leftover bandwidth because no transmit rate is configured.
- Low priority set—Consists of queue 0 and queue 3. Packets share the 20 Mbps of leftover bandwidth based on the configured transmit rate. The distribution of bandwidth is in proportion to the assigned percentages. Because the total assigned percentage is 40 (10 + 30), each queue receives a share of bandwidth accordingly. Thus queue 0 receives 5 Mbps ( $10/40 \times 20$ ), and queue 3 receives 15 Mbps ( $30/40 \times 20$ ).

**Related Documentation**

- [Junos OS Interfaces Configuration Guide for Security Devices](#)
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Schedulers Overview on page 43](#)
- [Default Scheduler Settings on page 48](#)
- [Example: Configuring Class-of-Service Schedulers on page 49](#)
- [Scheduler Buffer Size Overview on page 53](#)

- [Example: Configuring a Large Delay Buffer on a Channelized T1 Interface on page 55](#)
- [Example: Configuring and Applying Scheduler Maps on page 63](#)

## Excess Bandwidth Sharing and Minimum Logical Interface Shaping

The default excess bandwidth sharing proportional rate is 32.65 Mbps (128 Kbps x 255). In order to have better weighed fair queuing (WFQ) accuracy among queues, the shaping rate configured should be larger than the excess bandwidth sharing proportional rate. Some examples are shown in [Table 21 on page 67](#).

**Table 21: Shaping Rates and WFQ Weights**

| Shaping Rate | Configured Queue Transmit Rate | WFQ Weight        | Total Weights |
|--------------|--------------------------------|-------------------|---------------|
| 10 Mbps      | (30, 40, 25, 5)                | (22, 30, 20, 4)   | 76            |
| 33 Mbps      | (30, 40, 25, 5)                | (76, 104, 64, 13) | 257           |
| 40 Mbps      | (30, 40, 25, 5)                | (76, 104, 64, 13) | 257           |

With a 10-Mbps shaping rate, the total weights are 76. This is divided among the four queues according to the configured transmit rate. Note that when the shaping rate is larger than the excess bandwidth sharing proportional rate of 32.65 Mbps, the total weight on the logical interface is 257 and the WFQ accuracy will be the same.

When using the IOC (40x1GE IOC or 4x10GE IOC) on a Juniper Networks device, there are circumstances when you should configure excess bandwidth sharing and minimum logical interface shaping.

### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Schedulers Overview on page 43](#)
- [Excess Bandwidth Sharing Proportional Rates on page 67](#)
- [Calculated Weights Mapped to Hardware Weights on page 68](#)
- [Weight Allocation with Only Shaping Rates or Unshaped Logical Interfaces on page 69](#)
- [Shared Bandwidth Among Logical Interfaces on page 70](#)

## Excess Bandwidth Sharing Proportional Rates

To determine a good excess bandwidth-sharing proportional rate to configure, choose the largest CIR (guaranteed rate) among all the logical interfaces (units). If the logical units have PIRs (shaping rates) only, then choose the largest PIR rate. However, this is not ideal if a single logical interface has a large WRR rate. This method can skew the distribution of traffic across the queues of the other logical interfaces. To avoid this issue, set the excess bandwidth-sharing proportional rate to a lower value on the logical interfaces where the WRR rates are concentrated. This improves the bandwidth sharing

accuracy among the queues on the same logical interface. However, the excess bandwidth sharing for the logical interface with the larger WRR rate is no longer proportional.

As an example, consider five logical interfaces on the same physical port, each with four queues, all with only PIRs configured and no CIRs. The WRR rate is the same as the PIR for the logical interface. The excess bandwidth is shared proportionally with a rate of 40 Mbps. The traffic control profiles for the logical interfaces are shown in [Table 22 on page 68](#).

**Table 22: Example Shaping Rates and WFQ Weights**

| Shaping Rate      | Configured Queue Transmit Rate | WFQ Weight        | Total Weights |
|-------------------|--------------------------------|-------------------|---------------|
| (Unit 0) 10 Mbps  | (95, 0, 0, 5)                  | (60, 0, 0, 3)     | 63            |
| (Unit 1) 20 Mbps  | (25, 25, 25, 25)               | (32, 32, 32, 32)  | 128           |
| (Unit 2) 40 Mbps  | (40, 30, 20, 10)               | (102, 77, 51, 26) | 255           |
| (Unit 3) 200 Mbps | (70, 10, 10, 10)               | (179, 26, 26, 26) | 255           |
| (Unit 4) 2 Mbps   | (25, 25, 25, 25)               | (5, 5, 5, 5)      | 20            |

Even though the maximum transmit rate for the queue on logical interface unit 3 is 200 Mbps, the excess bandwidth-sharing proportional rate is kept at a much lower value. Within a logical interface, this method provides a more accurate distribution of weights across queues. However, the excess bandwidth is now shared equally between unit 2 and unit 3 (total weights = 255).

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Schedulers Overview on page 43](#)
- [Excess Bandwidth Sharing and Minimum Logical Interface Shaping on page 67](#)
- [Calculated Weights Mapped to Hardware Weights on page 68](#)
- [Weight Allocation with Only Shaping Rates or Unshaped Logical Interfaces on page 69](#)
- [Shared Bandwidth Among Logical Interfaces on page 70](#)

## Calculated Weights Mapped to Hardware Weights

The calculated weight in a traffic control profile is mapped to hardware weight, but the hardware only supports a limited WFQ profile. The weights are rounded to the nearest hardware weight according to the values in [Table 23 on page 68](#).

**Table 23: Rounding Configured Weights to Hardware Weights**

| Traffic Control Profile Number | Number of Traffic Control Profiles | Weights              | Maximum Error |
|--------------------------------|------------------------------------|----------------------|---------------|
| 1–16                           | 16                                 | 1–16 (interval of 1) | 50.00%        |

Table 23: Rounding Configured Weights to Hardware Weights (*continued*)

| Traffic Control Profile Number | Number of Traffic Control Profiles | Weights                  | Maximum Error |
|--------------------------------|------------------------------------|--------------------------|---------------|
| 17–29                          | 13                                 | 18–42 (interval of 2)    | 6.25%         |
| 30–35                          | 6                                  | 45–60 (interval of 3)    | 1.35%         |
| 36–43                          | 8                                  | 64–92 (interval of 4)    | 2.25%         |
| 44–49                          | 6                                  | 98–128 (interval of 6)   | 3.06%         |
| 50–56                          | 7                                  | 136–184 (interval of 8)  | 3.13%         |
| 57–62                          | 6                                  | 194–244 (interval of 10) | 2.71%         |
| 63–63                          | 1                                  | 255–255 (interval of 11) | 2.05%         |

As shown in [Table 23 on page 68](#), the calculated weight of 18.9 is mapped to a hardware weight of 18, because 18 is closer to 18.9 than 20 (an interval of 2 applies in the range of 18 to 42).

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Schedulers Overview on page 43](#)
- [Excess Bandwidth Sharing and Minimum Logical Interface Shaping on page 67](#)
- [Excess Bandwidth Sharing Proportional Rates on page 67](#)
- [Weight Allocation with Only Shaping Rates or Unshaped Logical Interfaces on page 69](#)
- [Shared Bandwidth Among Logical Interfaces on page 70](#)

## Weight Allocation with Only Shaping Rates or Unshaped Logical Interfaces

Logical interfaces with only shaping rates (PIRs) or unshaped logical interfaces (units) are given a weight of 10. A logical interface with a small guaranteed rate (CIR) might get an overall weight less than 10. To allocate a higher share of the excess bandwidth to logical interfaces with a small guaranteed rate in comparison to the logical interfaces with only shaping rates configured, a minimum weight of 20 is given to the logical interfaces with guaranteed rates configured.

For example, a logical interface configuration with five units is shown in [Table 24 on page 69](#).

Table 24: Allocating Weights with PIR and CIR on Logical Interfaces

| Logical Interface (Unit) | Traffic Control Profile | WRR Percentages | Weights     |
|--------------------------|-------------------------|-----------------|-------------|
| Unit 1                   | PIR 100 Mbps            | 95, 0, 0, 5     | 10, 1, 1, 1 |

Table 24: Allocating Weights with PIR and CIR on Logical Interfaces (*continued*)

| Logical Interface (Unit) | Traffic Control Profile  | WRR Percentages | Weights         |
|--------------------------|--------------------------|-----------------|-----------------|
| Unit 2                   | CIR 20 Mbps              | 25, 25, 25, 25  | 64, 64, 64, 64  |
| Unit 3                   | PIR 40 Mbps, CIR 20 Mbps | 50, 30, 15, 5   | 128, 76, 38, 13 |
| Unit 4                   | Unshaped                 | 95, 0, 0, 5     | 10, 1, 1, 1     |
| Unit 5                   | CIR 1 Mbps               | 95, 0, 0, 5     | 10, 1, 1, 1     |

The weights for these units are calculated as follows:

- The excess bandwidth-sharing proportional rate is the maximum CIR among all the logical interfaces which is 20 Mbps (unit 2).
- Unit 1 has a PIR and unit 4 is unshaped. The weight for these units is 10.
- The weight for unit 1 queue 0 is 9.5 (10 x 95%), which translates to a hardware weight of 10.
- The weight for unit 1 queue 1 is 0 (0 x 0%) but though the weight is zero, a weight of 1 is assigned to give minimal bandwidth to queues with zero WRR.
- Unit 5 has a very small CIR (1 Mbps), and a weight of 20 is assigned to units with a small CIR.
- The weight for unit 5 queue 0 is 19 (20 x 95%), which translates to a hardware weight of 18.
- Unit 3 has a CIR of 20 Mbps, which is the same as the excess bandwidth-sharing proportional rate, so it has a total weight of 255.
- The weight of unit 3 queue 0 is 127.5 (255 x 50%), which translates to a hardware weight of 128.

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Schedulers Overview on page 43](#)
- [Excess Bandwidth Sharing and Minimum Logical Interface Shaping on page 67](#)
- [Excess Bandwidth Sharing Proportional Rates on page 67](#)
- [Calculated Weights Mapped to Hardware Weights on page 68](#)
- [Shared Bandwidth Among Logical Interfaces on page 70](#)

## Shared Bandwidth Among Logical Interfaces

As a simple example showing how bandwidth is shared among the logical interfaces, assume that all traffic is sent on queue 0. Assume also that there is a 40-Mbps load on all of the logical interfaces. Configuration details are shown in [Table 25 on page 71](#).

Table 25: Example of Shared Bandwidth Among Logical Interfaces

| Logical Interface (Unit) | Traffic Control Profile  | WRR Percentages | Weights         |
|--------------------------|--------------------------|-----------------|-----------------|
| Unit 1                   | PIR 100 Mbps             | 95, 0, 0, 5     | 10, 1, 1, 1     |
| Unit 2                   | CIR 20 Mbps              | 25, 25, 25, 25  | 64, 64, 64, 64  |
| Unit 3                   | PIR 40 Mbps, CIR 20 Mbps | 50, 30, 15, 5   | 128, 76, 38, 13 |
| Unit 4                   | Unshaped                 | 95, 0, 0, 5     | 10, 1, 1, 1     |

When the port is shaped at 40 Mbps, because units 2 and 3 have a guaranteed rate (CIR) configured, both units 2 and 3 get 20 Mbps of shared bandwidth.

When the port is shaped at 100 Mbps, because units 2 and 3 have a guaranteed rate (CIR) configured, each of them can transmit 20 Mbps. On units 1, 2, 3, and 4, the 60 Mbps of excess bandwidth is shaped according to the values shown in [Table 26 on page 71](#).

Table 26: First Example of Bandwidth Sharing

| Logical Interface (Unit) | Calculation                           | Bandwidth  |
|--------------------------|---------------------------------------|------------|
| 1                        | $10 / (10+64+128+10) \times 60$ Mbps  | 2.83 Mbps  |
| 2                        | $64 / (10+64+128+10) \times 60$ Mbps  | 18.11 Mbps |
| 3                        | $128 / (10+64+128+10) \times 60$ Mbps | 36.22 Mbps |
| 4                        | $10 / (10+64+128+10) \times 60$ Mbps  | 2.83 Mbps  |

However, unit 3 only has 20 Mbps extra (PIR and CIR) configured. This means that the leftover bandwidth of 16.22 Mbps (36.22 Mbps – 20 Mbps) is shared among units 1, 2, and 4. This is shown in [Table 27 on page 71](#).

Table 27: Second Example of Bandwidth Sharing

| Logical Interface (Unit) | Calculation                             | Bandwidth  |
|--------------------------|-----------------------------------------|------------|
| 1                        | $10 / (10+64+128+10) \times 16.22$ Mbps | 1.93 Mbps  |
| 2                        | $64 / (10+64+128+10) \times 16.22$ Mbps | 12.36 Mbps |
| 4                        | $10 / (10+64+128+10) \times 16.22$ Mbps | 1.93 Mbps  |

Finally, [Table 28 on page 72](#) shows the resulting allocation of bandwidth among the logical interfaces when the port is configured with a 100-Mbps shaping rate.

Table 28: Final Example of Bandwidth Sharing

| Logical Interface (Unit) | Calculation                       | Bandwidth  |
|--------------------------|-----------------------------------|------------|
| 1                        | 2.83 Mbps + 1.93 Mbps             | 4.76 Mbps  |
| 2                        | 20 Mbps + 18.11 Mbps + 12.36 Mbps | 50.47 Mbps |
| 3                        | 20 Mbps + 20 Mbps                 | 40 Mbps    |
| 4                        | 2.83 Mbps + 1.93 Mbps             | 4.76 Mbps  |

**Related  
Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Schedulers Overview on page 43](#)
- [Excess Bandwidth Sharing and Minimum Logical Interface Shaping on page 67](#)
- [Excess Bandwidth Sharing Proportional Rates on page 67](#)
- [Calculated Weights Mapped to Hardware Weights on page 68](#)
- [Weight Allocation with Only Shaping Rates or Unshaped Logical Interfaces on page 69](#)



## CHAPTER 6

# Rewrite Rules

- [Rewrite Rules Overview on page 73](#)
- [Example: Configuring and Applying Rewrite Rules on page 73](#)
- [Rewriting Frame Relay Headers on page 77](#)

### Rewrite Rules Overview

---

A rewrite rule modifies the appropriate class-of-service (CoS) bits in an outgoing packet. Modification of CoS bits allows the next downstream device to classify the packet into the appropriate service group. Rewriting or marking outbound packets is useful when the device is at the border of a network and must alter the CoS values to meet the policies of the targeted peer. A rewrite rule examines the forwarding class and loss priority of a packet and sets its bits to a corresponding value specified in the rule.

Typically, a device rewrites CoS values in outgoing packets on the outbound interfaces of an edge device, to meet the policies of the targeted peer. After reading the current forwarding class and loss priority information associated with the packet, the transmitting device locates the chosen CoS value from a table, and writes this CoS value into the packet header.

#### Related Documentation

- [\*Junos OS Feature Support Reference for SRX Series and J Series Devices\*](#)
- [Example: Configuring and Applying Rewrite Rules on page 73](#)
- [Assigning the Default Frame Relay Rewrite Rule to an Interface on page 77](#)
- [Defining a Custom Frame Relay Rewrite Rule on page 77](#)

### Example: Configuring and Applying Rewrite Rules

---

This example shows how to configure and apply rewrite rules for a device.

- [Requirements on page 74](#)
- [Overview on page 74](#)
- [Configuration on page 75](#)
- [Verification on page 76](#)

## Requirements

Before you begin, create and configure the forwarding classes. See [“Example: Configuring Forwarding Classes” on page 35](#).

## Overview

You can configure rewrite rules to replace DSCPs on packets received from the customer or host with the values expected by other devices. You do not have to configure rewrite rules if the received packets already contain valid DSCPs. Rewrite rules apply the forwarding class information and packet loss priority used internally by the device to establish the DSCP on outbound packets. After you configure the rewrite rules, you must apply them to the correct interfaces.

In this example, you configure the rewrite rules for DiffServ CoS as rewrite-dscps. You specify the best-effort forwarding class as be-class, expedited forwarding class as ef-class, an assured forwarding class as af-class, and a network control class as nc-class. Finally, you apply rewrite rules to an interface called ge-0/0/0.

[Table 29 on page 74](#) shows how the rewrite rules replace the DSCPs on packets in the four forwarding classes.

**Table 29: Sample rewrite-dscps Rewrite Rules to Replace DSCPs**

| mf-classifier<br>Forwarding Class | For CoS Traffic Type                                                                                                                                                   | rewrite-dscps Rewrite Rules                                         |
|-----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| be-class                          | Best-effort traffic—Provides no special CoS handling of packets. Typically, RED drop profile is aggressive and no loss priority is defined.                            | Low-priority code point: 000000<br>High-priority code point: 000001 |
| ef-class                          | Expedited forwarding traffic—Provides low loss, low delay, low jitter, assured bandwidth, and end-to-end service. Packets can be forwarded out of sequence or dropped. | Low-priority code point: 101110<br>High-priority code point: 101111 |
| af-class                          | Assured forwarding traffic—Provides high assurance for packets within the specified service profile. Excess packets are dropped.                                       | Low-priority code point: 001010<br>High-priority code point: 001100 |
| nc-class                          | Network control traffic—Packets can be delayed but not dropped.                                                                                                        | Low-priority code point: 110000<br>High-priority code point: 110001 |



**NOTE:** Forwarding classes can be configured in a DSCP rewriter and also as an action of an IDP policy to rewrite DSCP code points. To ensure that the forwarding class is used as an action in an IDP policy, it is important that you do not configure an IDP policy and interface-based rewrite rules with the same forwarding class. For more information on applying a CoS action in an IDP policy, see the [Junos OS Security Configuration Guide](#).

## Configuration

**CLI Quick Configuration** To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service rewrite-rules dscp rewrite-dscps forwarding-class be-class
  loss-priority low code-point 000000
set class-of-service rewrite-rules dscp rewrite-dscps forwarding-class be-class
  loss-priority high code-point 000001
set class-of-service rewrite-rules dscp rewrite-dscps forwarding-class ef-class loss-priority
  low code-point 101110
set class-of-service rewrite-rules dscp rewrite-dscps forwarding-class ef-class loss-priority
  high code-point 101111
set class-of-service rewrite-rules dscp rewrite-dscps forwarding-class af-class loss-priority
  low code-point 001010
set class-of-service rewrite-rules dscp rewrite-dscps forwarding-class af-class loss-priority
  high code-point 001100
set class-of-service rewrite-rules dscp rewrite-dscps forwarding-class nc-class loss-priority
  low code-point 110000
set class-of-service rewrite-rules dscp rewrite-dscps forwarding-class nc-class loss-priority
  high code-point 110001
set class-of-service interfaces ge-0/0/0 unit 0 rewrite-rules dscp rewrite-dscps
```

**Step-by-Step Procedure** The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see *Using the CLI Editor in Configuration Mode* in the *Junos OS CLI User Guide*.

To configure and apply rewrite rules for a device:

1. Configure rewrite rules for DiffServ CoS.  

```
[edit]
user@host# edit class-of-service
user@host# edit rewrite-rules dscp rewrite-dscps
```
2. Configure best-effort forwarding class rewrite rules.  

```
[edit class-of-service rewrite-rules dscp rewrite-dscps]
user@host# set forwarding-class be-class loss-priority low code-point 000000
user@host# set forwarding-class be-class loss-priority high code-point 000001
```
3. Configure expedited forwarding class rewrite rules.  

```
[edit class-of-service rewrite-rules dscp rewrite-dscps]
user@host# set forwarding-class ef-class loss-priority low code-point 101110
user@host# set forwarding-class ef-class loss-priority high code-point 101111
```
4. Configure an assured forwarding class rewrite rules.  

```
[edit class-of-service rewrite-rules dscp rewrite-dscps]
user@host# set forwarding-class af-class loss-priority low code-point 001010
user@host# set forwarding-class af-class loss-priority high code-point 001100
```
5. Configure a network control class rewrite rules.  

```
[edit class-of-service rewrite-rules dscp rewrite-dscps]
```

```
user@host# set forwarding-class nc-class loss-priority low code-point 110000
user@host# set forwarding-class nc-class loss-priority high code-point 110001
```

6. Apply rewrite rules to an interface.

```
[edit class-of-service]
user@host# set interfaces ge-0/0/0 unit 0 rewrite-rules dscp rewrite-dscps
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service
interfaces {
  interfaces {
    unit 0 {
      rewrite-rules {
        dscp rewrite-dscps;
      }
    }
  }
}
rewrite-rules {
  dscp rewrite-dscps {
    forwarding-class be-class {
      loss-priority low code-point 000000;
      loss-priority high code-point 000001;
    }
    forwarding-class ef-class {
      loss-priority low code-point 101110;
      loss-priority high code-point 101111;
    }
    forwarding-class af-class {
      loss-priority low code-point 001010;
      loss-priority high code-point 001100;
    }
    forwarding-class nc-class {
      loss-priority low code-point 110000;
      loss-priority high code-point 110001;
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

Confirm that the configuration is working properly.

- [Verifying Rewrite Rules Configuration on page 76](#)

---

### Verifying Rewrite Rules Configuration

**Purpose** Verify that rewrite rules are configured properly.

**Action** From configuration mode, enter the **show class-of-service** command.

- Related Documentation**
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
  - [Rewrite Rules Overview on page 73](#)
  - [Assigning the Default Frame Relay Rewrite Rule to an Interface on page 77](#)
  - [Defining a Custom Frame Relay Rewrite Rule on page 77](#)

## Rewriting Frame Relay Headers

This section contains the following topics:

- [Assigning the Default Frame Relay Rewrite Rule to an Interface on page 77](#)
- [Defining a Custom Frame Relay Rewrite Rule on page 77](#)

### Assigning the Default Frame Relay Rewrite Rule to an Interface

For Juniper Networks device interfaces with Frame Relay encapsulation, you can rewrite the discard eligibility (DE) bit based on the loss priority of Frame Relay traffic. For each outgoing frame with the loss priority set to low, medium-low, medium-high, or high, you can set the DE bit CoS value to 0 or 1. You can combine a Frame Relay rewrite rule with other rewrite rules on the same interface. For example, you can rewrite both the DE bit and MPLS EXP bit.

The default Frame Relay rewrite rule contains the following settings:

```
loss-priority low code-point 0;
loss-priority medium-low code-point 0;
loss-priority medium-high code-point 1;
loss-priority high code-point 1;
```

This default rule sets the DE CoS value to 0 for each outgoing frame with the loss priority set to low or medium-low. This default rule sets the DE CoS value to 1 for each outgoing frame with the loss priority set to medium-high or high.

To assign the default rule to an interface, include the **frame-relay-de default** statement at the **[edit class-of-service interfaces interface *interface-name* unit *logical-unit-number* rewrite-rules]** hierarchy level:

```
[edit class-of-service interfaces interface-name unit logical-unit-number rewrite-rules]
frame-relay-de default;
```

### Defining a Custom Frame Relay Rewrite Rule

To define a custom Frame Relay rewrite rule, include the following statements at the **[edit class-of-service]** hierarchy level:

```
[edit class-of-service]
rewrite-rules {
  frame-relay-de rewrite-name {
    import (rewrite-name | default);
```

```
forwarding-class class-name {  
    loss-priority level code-point (0 | 1);  
}  
}
```

A custom rewrite rule sets the DE bit to the 0 or 1 CoS value based on the assigned loss priority of low, medium-low, medium-high, or high for each outgoing frame.

The rule does not take effect until you apply it to a logical interface. To apply a rule to a logical interface, include the **frame-relay-de *map-name*** statement at the **[edit class-of-service interfaces *interface-name* unit *logical-unit-number* rewrite-rules]** hierarchy level:

```
[edit class-of-service interfaces interface-name unit logical-unit-number rewrite-rules]  
frame-relay-de map-name;
```

**Related  
Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Rewrite Rules Overview on page 73](#)
- [Example: Configuring and Applying Rewrite Rules on page 73](#)

## CHAPTER 7

# CoS Filters and Policers

- [Simple Filters and Policers Overview on page 79](#)
- [Guidelines for Configuring Simple Filters on page 80](#)
- [Two-Rate Three-Color Policer Overview on page 83](#)
- [Example: Configuring a Two-Rate Three-Color Policer on page 84](#)
- [Example: Configuring and Applying a Firewall Filter for a Multifield Classifier on page 89](#)

## Simple Filters and Policers Overview

---

You can configure simple filters and policers to handle oversubscribed traffic in SRX1400, SRX3400, SRX3600, SRX5600, and SRX5800 devices. In Junos OS, policers can be configured as part of the firewall filter hierarchy.



**NOTE:** For SRX5600 and SRX5800 devices, the simple filter or policing actions can be applied only to logical interfaces residing in an SRX5000 line Flex IOC (FIOC) because only an SRX5000 line FIOC supports the simple filter and policing features on the SRX5600 and SRX5800 devices.

The simple filter functionality consists of the following:

- Classifying packets according to configured policies
- Taking appropriate actions based on the results of classification

In Junos OS, ingress traffic policers can limit the rate of incoming traffic. Two main reasons to use traffic policing are:

- To enforce traffic rates to conform to the service-level agreement (SLA)
- To protect next hops, such as protecting the central point and the SPU from being overwhelmed by excess traffic like DOS attacks

Using the results of packet classification and traffic metering, a policer can take one of the following actions for a packet: forward a conforming (green) packet or drop a nonconforming (yellow) packet. Policers always discard a nonconforming red packet. Traffic metering supports the algorithm of the two-rate tricolor marker (TCM). (See RFC 2698, *A Two Rate Three Color Marker*.)

**Related Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Junos OS Security Configuration Guide](#)
- [Guidelines for Configuring Simple Filters on page 80](#)
- [Example: Configuring a Two-Rate Three-Color Policer on page 84](#)
- [Example: Configuring and Applying a Firewall Filter for a Multifield Classifier on page 89](#)

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## Guidelines for Configuring Simple Filters

This topic covers the following information:

- [Statement Hierarchy for Configuring Simple Filters on page 80](#)
- [Simple Filter Protocol Families on page 80](#)
- [Simple Filter Names on page 81](#)
- [Simple Filter Terms on page 81](#)
- [Simple Filter Match Conditions on page 81](#)
- [Simple Filter Terminating Actions on page 82](#)
- [Simple Filter Nonterminating Actions on page 83](#)

### Statement Hierarchy for Configuring Simple Filters

To configure a simple filter, include the **simple-filter** *simple-filter-name* statement at the **[edit firewall family inet]** hierarchy level.

```
[edit]
firewall {
  family inet {
    simple-filter simple-filter-name {
      term term-name {
        from {
          match-conditions;
        }
        then {
          actions;
        }
      }
    }
  }
}
```

Individual statements supported under the **simple-filter** *simple-filter-name* statement are described separately in this topic and are illustrated in the example of configuring and applying a simple filter.

### Simple Filter Protocol Families

You can configure simple filters to filter IPv4 traffic (**family inet**) only. No other protocol family is supported for simple filters.





**NOTE:** You can apply simple filters to the family inet only, and only in the input direction. Because of hardware limitations on the SRX1400, SRX3400, SRX3600, SRX5600, and SRX5800 devices, a maximum of 400 logical input interfaces (in one Broadcom packet processor) can be applied with simple filters.

## Simple Filter Names

Under the **family inet** statement, you can include **simple-filter *simple-filter-name*** statements to create and name simple filters. The filter name can contain letters, numbers, and hyphens (-) and be up to 64 characters long. To include spaces in the name, enclose the entire name in quotation marks (" ").

## Simple Filter Terms

Under the **simple-filter *simple-filter-name*** statement, you can include **term *term-name*** statements to create and name filter terms.

- You must configure at least one term in a firewall filter.
- You must specify a unique name for each term within a firewall filter. The term name can contain letters, numbers, and hyphens (-) and can be up to 64 characters long. To include spaces in the name, enclose the entire name in quotation marks (" ").
- The order in which you specify terms within a firewall filter configuration is important. Firewall filter terms are evaluated in the order in which they are configured. By default, new terms are always added to the end of the existing filter. You can use the **insert** configuration mode command to reorder the terms of a firewall filter.

Simple filters do *not* support the **next term** action.

## Simple Filter Match Conditions

Simple filter terms support only a subset of the IPv4 match conditions that are supported for standard stateless firewall filters.

Unlike standard stateless firewall filters, the following restrictions apply to simple filters:

- On MX Series routers with the Enhanced Queuing DPC, simple filters do *not* support the **forwarding-class** match condition.
- Simple filters support only one **source-address** and one **destination-address** prefix for each filter term. If you configure multiple prefixes, only the last one is used.
- Simple filters do *not* support multiple source addresses and destination addresses in a single term. If you configure multiple addresses, only the last one is used.
- Simple filters do *not* support negated match conditions, such as the **protocol-except** match condition or the **exception** keyword.

- Simple filters support a range of values for **source-port** and **destination-port** match conditions only. For example, you can configure **source-port 400-500** or **destination-port 600-700**.
- Simple filters do *not* support noncontiguous mask values.

Table 30 on page 82 lists the simple filter match conditions.

Table 30: Simple Filter Match Conditions

| Match Condition                                          | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|----------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>destination-address</b><br><i>destination-address</i> | Match IP destination address.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>destination-port</b><br><i>number</i>                 | <p>TCP or UDP destination port field.</p> <p>If you configure this match condition, we recommend that you also configure the <b>protocol</b> match statement to determine which protocol is being used on the port.</p> <p>In place of the numeric value, you can specify one of the following text aliases (the port numbers are also listed): <b>afs</b> (1483), <b>bgp</b> (179), <b>biff</b> (512), <b>bootpc</b> (68), <b>bootps</b> (67), <b>cmd</b> (514), <b>cvspserver</b> (2401), <b>dhcp</b> (67), <b>domain</b> (53), <b>eklogin</b> (2105), <b>ekshell</b> (2106), <b>exec</b> (512), <b>finger</b> (79), <b>ftp</b> (21), <b>ftp-data</b> (20), <b>http</b> (80), <b>https</b> (443), <b>ident</b> (113), <b>imap</b> (143), <b>kerberos-sec</b> (88), <b>klogin</b> (543), <b>kpasswd</b> (761), <b>krb-prop</b> (754), <b>krbupdate</b> (760), <b>kshell</b> (544), <b>ldap</b> (389), <b>login</b> (513), <b>mobileip-agent</b> (434), <b>mobilip-mn</b> (435), <b>msdp</b> (639), <b>netbios-dgm</b> (138), <b>netbios-ns</b> (137), <b>netbios-ssn</b> (139), <b>nfsd</b> (2049), <b>nntp</b> (119), <b>ntalk</b> (518), <b>ntp</b> (123), <b>pop3</b> (110), <b>pptp</b> (1723), <b>printer</b> (515), <b>radacct</b> (1813), <b>radius</b> (1812), <b>rip</b> (520), <b>rkinit</b> (2108), <b>smtp</b> (25), <b>snmp</b> (161), <b>snmptrap</b> (162), <b>snpp</b> (444), <b>socks</b> (1080), <b>ssh</b> (22), <b>sunrpc</b> (111), <b>syslog</b> (514), <b>tacacs-ds</b> (65), <b>talk</b> (517), <b>telnet</b> (23), <b>tftp</b> (69), <b>timed</b> (525), <b>who</b> (513), or <b>xdmcp</b> (177).</p> |
| <b>forwarding-class</b> <i>class</i>                     | <p>Match the forwarding class of the packet.</p> <p>Specify <b>assured-forwarding</b>, <b>best-effort</b>, <b>expedited-forwarding</b>, or <b>network-control</b>.</p> <p>For information about forwarding classes and router-internal output queues, see the <a href="#">Junos OS Class of Service Configuration Guide</a>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>protocol</b> <i>number</i>                            | IP protocol field. In place of the numeric value, you can specify one of the following text aliases (the field values are also listed): <b>ah</b> (51), <b>dstopts</b> (60), <b>egp</b> (8), <b>esp</b> (50), <b>fragment</b> (44), <b>gre</b> (47), <b>hop-by-hop</b> (0), <b>icmp</b> (1), <b>icmp6</b> (58), <b>icmpv6</b> (58), <b>igmp</b> (2), <b>ipip</b> (4), <b>ip6v6</b> (41), <b>ospf</b> (89), <b>pim</b> (103), <b>rsvp</b> (46), <b>sctp</b> (132), <b>tcp</b> (6), <b>udp</b> (17), or <b>vrrp</b> (112).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>source-address</b><br><i>ip-source-address</i>        | Match the IP source address.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>source-port</b> <i>number</i>                         | <p>Match the UDP or TCP source port field.</p> <p>If you configure this match condition, we recommend that you also configure the <b>protocol</b> match statement to determine which protocol is being used on the port.</p> <p>In place of the numeric field, you can specify one of the text aliases listed for <b>destination-port</b>.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

## Simple Filter Terminating Actions

Simple filters do *not* support explicitly configurable terminating actions, such as **accept**, **reject**, and **discard**. Terms configured in a simple filter always accept packets.

Simple filters do *not* support the **next** action.

## Simple Filter Nonterminating Actions

Simple filters support only the following nonterminating actions:

- **forwarding-class** (*forwarding-class* | **assured-forwarding** | **best-effort** | **expedited-forwarding** | **network-control**)



**NOTE:** On the MX Series routers with the Enhanced Queuing DPC, the forwarding class is not supported as a **from** match condition.

- **loss-priority** (**high** | **low** | **medium-high** | **medium-low**)

Simple filters do not support actions that perform other functions on a packet (such as incrementing a counter, logging information about the packet header, sampling the packet data, or sending information to a remote host using the system log functionality).

### Related Documentation

- [Simple Filters and Policers Overview on page 79](#)

## Two-Rate Three-Color Policer Overview

A two-rate three-color policer defines two bandwidth limits (one for guaranteed traffic and one for peak traffic) and two burst sizes (one for each of the bandwidth limits). A two-rate three-color policer is most useful when a service is structured according to arrival rates and not necessarily packet length.

Two-rate three-color policing meters a traffic stream based on the following configured traffic criteria:

- Committed information rate (CIR)—Bandwidth limit for guaranteed traffic.
- Committed burst size (CBS)—Maximum packet size permitted for bursts of data that exceed the CIR.
- Peak information rate (PIR)—Bandwidth limit for peak traffic.
- Peak burst size (PBS)—Maximum packet size permitted for bursts of data that exceed the PIR.

Two-rate tricolor marking (two-rate TCM) classifies traffic as belonging to one of three color categories and performs congestion-control actions on the packets based on the color marking:

- Green—Traffic that conforms to the bandwidth limit and burst size for guaranteed traffic (CIR and CBS). For a green traffic flow, two-rate TCM marks the packets with an implicit loss priority of **low** and transmits the packets.
- Yellow—Traffic that exceeds the bandwidth limit or burst size for guaranteed traffic (CIR or CBS) but not the bandwidth limit and burst size for peak traffic (PIR and PBS).

For a yellow traffic flow, two-rate TCM marks packets with an implicit loss priority of **medium-high** and transmits the packets.

- Red—Traffic that exceeds the bandwidth limit and burst size for peak traffic (PIR and PBS). For a red traffic flow, two-rate TCM marks packets with an implicit loss priority of **high** and, optionally, discards the packets.

If congestion occurs downstream, the packets with higher loss priority are more likely to be discarded.



**NOTE:** For both single-rate and two-rate three-color policers, the only *configurable* action is to discard packets in a red traffic flow.

---

For a tricolor marking policer referenced by a firewall filter term, the **discard** policing action is supported on the following routing platforms:

- M7i and M10i routers with the Enhanced CFEB (CFEB-E)
- M120 and M320 routers with Enhanced-III FPCs
- MX Series routers with Trio MPCs

To apply a tricolor marking policer on these routing platforms, it is not necessary to include the **logical-interface-policer** statement.

**Related  
Documentation**

- [Example: Configuring a Two-Rate Three-Color Policer on page 84](#)

---

## Example: Configuring a Two-Rate Three-Color Policer

---

This example shows how to configure a two-rate three-color policer.

- [Requirements on page 84](#)
- [Overview on page 84](#)
- [Configuration on page 85](#)
- [Verification on page 88](#)

### Requirements

No special configuration beyond device initialization is required before configuring this example.

### Overview

A two-rate three-color policer meters a traffic flow against a bandwidth limit and burst-size limit for guaranteed traffic, plus a bandwidth limit and burst-size limit for peak traffic. Traffic that conforms to the limits for guaranteed traffic is categorized as green, and nonconforming traffic falls into one of two categories:

- Nonconforming traffic that does not exceed peak traffic limits is categorized as yellow.

- Nonconforming traffic that exceeds peak traffic limits is categorized as red.

Each category is associated with an action. For green traffic, packets are implicitly set with a loss-priority value of **low** and then transmitted. For yellow traffic, packets are implicitly set with a loss-priority value of **medium-high** and then transmitted. For red traffic, packets are implicitly set with a loss-priority value of **high** and then transmitted. If the policer configuration includes the optional **action** statement (**action loss-priority high then discard**), then packets in a red flow are discarded instead.

You can apply a three-color policer to Layer 3 traffic as a firewall filter policer only. You reference the policer from a stateless firewall filter term, and then you apply the filter to the input or output of a logical interface at the protocol level.

### Topology

In this example, you apply a color-aware, two-rate three-color policer to the input IPv4 traffic at logical interface **fe-0/1/1.0**. The IPv4 firewall filter term that references the policer does not apply any packet-filtering. The filter is used only to apply the three-color policer to the interface.

You configure the policer to rate-limit traffic to a bandwidth limit of 40 Mbps and a burst-size limit of 100 KB for green traffic, and you configure the policer to also allow a peak bandwidth limit of 60 Mbps and a peak burst-size limit of 200 KB for yellow traffic. Only nonconforming traffic that exceeds the peak traffic limits is categorized as red. In this example, you configure the three-color policer action **loss-priority high then discard**, which overrides the implicit marking of red traffic to a **high** loss priority.

## Configuration

The following example requires you to navigate various levels in the configuration hierarchy. For information about navigating the CLI, see *Using the CLI Editor in Configuration Mode*.

To configure this example, perform the following tasks:

- [Configuring a Two-Rate Three-Color Policer on page 86](#)
- [Configuring an IPv4 Stateless Firewall Filter That References the Policer on page 87](#)
- [Applying the Filter to a Logical Interface at the Protocol Family Level on page 88](#)

### CLI Quick Configuration

To quickly configure this example, copy the following configuration commands into a text file, remove any line breaks, and then paste the commands into the CLI at the **[edit]** hierarchy level.

```
set firewall three-color-policer trTCM1-ca two-rate color-aware
set firewall three-color-policer trTCM1-ca two-rate committed-information-rate 40m
set firewall three-color-policer trTCM1-ca two-rate committed-burst-size 100k
set firewall three-color-policer trTCM1-ca two-rate peak-information-rate 60m
set firewall three-color-policer trTCM1-ca two-rate peak-burst-size 200k
set firewall three-color-policer trTCM1-ca action loss-priority high then discard
set firewall family inet filter filter-trtcm1ca-all term 1 then three-color-policer two-rate
trTCM1-ca
set interfaces ge-2/0/5 unit 0 family inet address 10.10.10.1/30
set interfaces ge-2/0/5 unit 0 family inet filter input filter-trtcm1ca-all
```

```
set class-of-service interfaces ge-2/0/5 forwarding-class af
```

### Configuring a Two-Rate Three-Color Policer

---

#### Step-by-Step Procedure

To configure a two-rate three-color policer:

1. Enable configuration of a three-color policer.

```
[edit]
user@host# set firewall three-color-policer trTCM1-ca
```

2. Configure the color mode of the two-rate three-color policer.

```
[edit firewall three-color-policer trTCM1-ca]
user@host# set two-rate color-aware
```

3. Configure the two-rate guaranteed traffic limits.

```
[edit firewall three-color-policer trTCM1-ca]
user@host# set two-rate committed-information-rate 40m
user@host# set two-rate committed-burst-size 100k
```

Traffic that does not exceed both of these limits is categorized as green. Packets in a green flow are implicitly set to **low** loss priority and then transmitted.

4. Configure the two-rate peak traffic limits.

```
[edit firewall three-color-policer trTCM1-ca]
user@host# set two-rate peak-information-rate 60m
user@host# set two-rate peak-burst-size 200k
```

Nonconforming traffic that does not exceed both of these limits is categorized as yellow. Packets in a yellow flow are implicitly set to **medium-high** loss priority and then transmitted. Nonconforming traffic that exceeds both of these limits is categorized as red. Packets in a red flow are implicitly set to **high** loss priority.

5. (Optional) Configure the policer action for red traffic.

```
[edit firewall three-color-policer trTCM1-ca]
user@host# set action loss-priority high then discard
```

For three-color policers, the only configurable action is to discard red packets. Red packets are packets that have been assigned high loss priority because they exceeded the peak information rate (PIR) and the peak burst size (PBS).

**Results** Confirm the configuration of the policer by entering the **show firewall** configuration mode command. If the command output does not display the intended configuration, repeat the instructions in this procedure to correct the configuration.

```
[edit]
user@host# show firewall
three-color-policer trTCM1-ca {
  action {
    loss-priority high then discard;
  }
  two-rate {
    color-aware;
    committed-information-rate 40m;
```

```

    committed-burst-size 100k;
    peak-information-rate 60m;
    peak-burst-size 200k;
  }
}

```

### Configuring an IPv4 Stateless Firewall Filter That References the Policer

#### Step-by-Step Procedure

To configure an IPv4 stateless firewall filter that references the policer:

1. Enable configuration of an IPv4 standard stateless firewall filter.

```

[edit]
user@host# set firewall family inet filter filter-trtcm1ca-all

```

2. Specify the filter term that references the policer.

```

[edit firewall family inet filter filter-trtcm1ca-all]
user@host# set term 1 then three-color-policer two-rate trTCM1-ca

```

Note that the term does not specify any match conditions. The firewall filter passes all packets to the policer.

**Results** Confirm the configuration of the firewall filter by entering the **show firewall** configuration mode command. If the command output does not display the intended configuration, repeat the instructions in this procedure to correct the configuration.

```

[edit]
user@host# show firewall
family inet {
  filter filter-trtcm1ca-all {
    term 1 {
      then {
        three-color-policer {
          two-rate trTCM1-ca;
        }
      }
    }
  }
}
three-color-policer trTCM1-ca {
  action {
    loss-priority high then discard;
  }
  two-rate {
    color-aware;
    committed-information-rate 40m;
    committed-burst-size 100k;
    peak-information-rate 60m;
    peak-burst-size 200k;
  }
}

```

### Applying the Filter to a Logical Interface at the Protocol Family Level

|                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Step-by-Step Procedure</b> | <p>To apply the filter to the logical interface at the protocol family level:</p> <ol style="list-style-type: none"> <li>1. Enable configuration of an IPv4 firewall filter.           <pre>[edit] user@host# edit interfaces ge-2/0/5 unit 0 family inet</pre> </li> <li>2. Apply the policer to the logical interface at the protocol family level.           <pre>[edit interfaces ge-2/0/5 unit 0 family inet] user@host# set address 10.10.10.1/30 user@host# set filter input filter-trtcm1ca-all</pre> </li> <li>3. (MX Series routers only) (Optional) For input policers, you can configure a fixed classifier. A fixed classifier reclassifies all incoming packets, regardless of any preexisting classification.           <pre>[edit] user@host# set class-of-service interfaces ge-2/0/5 forwarding-class af</pre> <p>The classifier name can be a configured classifier or one of the default classifiers.</p> </li> </ol> |
| <b>Results</b>                | <p>Confirm the configuration of the interface by entering the <b>show interfaces</b> configuration mode command. If the command output does not display the intended configuration, repeat the instructions in this procedure to correct the configuration.</p> <pre>[edit] user@host# show interfaces ge-2/0/5 {   unit 0 {     family inet {       address 10.10.10.1/30;       filter {         input filter-trtcm1ca-all;       }     }   } }</pre> <p>If you are done configuring the device, enter <b>commit</b> from configuration mode.</p>                                                                                                                                                                                                                                                                                                                                                                                       |

### Verification

Confirm that the configuration is working properly.

- [Displaying the Firewall Filters Applied to the Logical Interface on page 88](#)

### Displaying the Firewall Filters Applied to the Logical Interface

|                |                                                                                                                                                                                                            |
|----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b> | Verify that the firewall filter is applied to IPv4 input traffic at the logical interface.                                                                                                                 |
| <b>Action</b>  | Use the <b>show interfaces</b> operational mode command for the logical interface <b>ge-2/0/5.0</b> , and specify <b>detail</b> mode. The <b>Protocol inet</b> section of the command output displays IPv4 |



information for the logical interface. Within that section, the **Input Filters** field displays the name of IPv4 firewall filters associated with the logical interface.

```
user@host> show interfaces ge-2/0/5.0 detail
Logical interface ge-2/0/5.0 (Index 105) (SNMP ifIndex 556) (Generation 170)
Flags: Device-Down SNMP-Traps 0x4004000 Encapsulation: ENET2
Traffic statistics:
  Input bytes : 0
  Output bytes : 0
  Input packets: 0
  Output packets: 0
Local statistics:
  Input bytes : 0
  Output bytes : 0
  Input packets: 0
  Output packets: 0
Transit statistics:
  Input bytes : 0 0 bps
  Output bytes : 0 0 bps
  Input packets: 0 0 pps
  Output packets: 0 0 pps
Protocol inet, MTU: 1500, Generation: 242, Route table: 0
Flags: Sendbroadcast-pkt-to-re
Input Filters: filter-trtcm1ca-all
Addresses, Flags: Dest-route-down Is-Preferred Is-Primary
Destination: 10.20.130/24, Local: 10.20.130.1, Broadcast: 10.20.130.255,
Generation: 171
Protocol multiservice, MTU: Unlimited, Generation: 243, Route table: 0
Policer: Input: __default_arp_policer__
```

**Related Documentation**

- [Two-Rate Three-Color Policer Overview on page 83](#)

## Example: Configuring and Applying a Firewall Filter for a Multifield Classifier

This example shows how to configure a firewall filter to classify traffic using a multifield classifier. The classifier detects packets of interest to CoS as they arrive on an interface.

- [Requirements on page 89](#)
- [Overview on page 90](#)
- [Configuration on page 90](#)
- [Verification on page 93](#)

### Requirements

Before you begin, review how to create and configure a firewall. See [Guidelines for Configuring Standard Firewall Filters](#).



**NOTE:** On T4000 Type 5 FPCs, a filter attached at the Layer 2 application point (that is, at the logical interface level) is unable to match with the forwarding class of a packet that is set by a Layer 3 classifier such as DSCP, DSCP V6, inet-precedence, and mpls-exp.

## Overview

One common way to detect packets of CoS interest is by source or destination address. The destination address is used in this example, but many other matching criteria for packet detection are available to firewall filters.

In this example, you configure the firewall filter `mf-classifier`. You create and name the assured forwarding traffic class, set the match condition, and specify the destination address as `192.168.44.55`. You create the forwarding class for assured forwarding DiffServ traffic as `af-class` and set the loss priority to low.

Then you create and name the expedited forwarding traffic class, set the match condition, for the expedited forwarding traffic class, and specify the destination address as `192.168.66.77`. You then create the forwarding class for expedited forwarding DiffServ traffic as `ef-class` and set the policer to `ef-policer`. Then you create and name the network-control traffic class and set the match condition.

You then create and name the forwarding class for the network control traffic class as `nc-class`. You create and name the forwarding class for the best-effort traffic class as `be-class`. Finally, you apply the multifield classifier firewall filter as an input filter on each customer-facing or host-facing that needs the filter. In this example, the interface is `ge-0/0/0`.

## Configuration

### CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set firewall filter mf-classifier interface-specific
set firewall filter mf-classifier term assured-forwarding from destination-address
  192.168.44.55
set firewall filter mf-classifier term assured-forwarding then forwarding-class af-class
set firewall filter mf-classifier term assured-forwarding then loss-priority low
set firewall filter mf-classifier term expedited-forwarding from destination-address
  192.168.66.77
set firewall filter mf-classifier term expedited-forwarding then forwarding-class ef-class
set firewall filter mf-classifier term expedited-forwarding then policer ef-policer
set firewall filter mf-classifier term network-control from precedence net-control
set firewall filter mf-classifier term network-control then forwarding-class nc-class
set firewall filter mf-classifier term best-effort then forwarding-class be-class
set interfaces ge-0/0/0 unit 0 family inet filter input mf-classifier
```

### Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see *Using the CLI Editor in Configuration Mode* in the [Junos OS CLI User Guide](#).

To configure a firewall filter for a multifield classifier for a device:

1. Create and name the multifield classifier filter.

**[edit]**

- ```

user@host# edit firewall filter mf-classifier
user@host# set interface-specific

```
2. Create and name the term for the assured forwarding traffic class.
 

```

[edit firewall filter mf-classifier]
user@host# edit term assured-forwarding

```
  3. Specify the destination address for assured forwarding traffic.
 

```

[edit firewall filter mf-classifier term assured-forwarding]
user@host# set from destination-address 192.168.44.55

```
  4. Create the forwarding class and set the loss priority for the assured forwarding traffic class.
 

```

[edit firewall filter mf-classifier term assured-forwarding]
user@host# set then forwarding-class af-class
user@host# set then loss-priority low

```
  5. Create and name the term for the expedited forwarding traffic class.
 

```

[edit]
user@host# edit firewall filter mf-classifier
user@host# edit term expedited-forwarding

```
  6. Specify the destination address for the expedited forwarding traffic.
 

```

[edit firewall filter mf-classifier term expedited-forwarding]
user@host# set from destination-address 192.168.66.77

```
  7. Create the forwarding class and apply the policer for the expedited forwarding traffic class.
 

```

[edit firewall filter mf-classifier term expedited-forwarding]
user@host# set then forwarding-class ef-class
user@host# set then policer ef-policer

```
  8. Create and name the term for the network control traffic class.
 

```

[edit]
user@host# edit firewall filter mf-classifier
user@host# edit term network-control

```
  9. Create the match condition for the network control traffic class.
 

```

[edit firewall filter mf-classifier term network-control]
user@host# set from precedence net-control

```
  10. Create and name the forwarding class for the network control traffic class.
 

```

[edit firewall filter mf-classifier term network-control]
user@host# set then forwarding-class nc-class

```
  11. Create and name the term for the best-effort traffic class.
 

```

[edit]
user@host# edit firewall filter mf-classifier
user@host# edit term best-effort

```
  12. Create and name the forwarding class for the best-effort traffic class.
 

```

[edit firewall filter mf-classifier term best-effort]
user@host# set then forwarding-class be-class

```



**NOTE:** Because this is the last term in the filter, it has no match condition.

13. Apply the multifield classifier firewall filter as an input filter.

[edit]

```
user@host# set interfaces ge-0/0/0 unit 0 family inet filter input mf-classifier
```

**Results** From configuration mode, confirm your configuration by entering the **show firewall filter mf-classifier** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

[edit]

```
user@host# show firewall filter mf-classifier
interface-specific;
term assured-forwarding {
  from {
    destination-address {
      192.168.44.55/32;
    }
  }
  then {
    loss-priority low;
    forwarding-class af-class;
  }
}
term expedited-forwarding {
  from {
    destination-address {
      192.168.66.77/32;
    }
  }
  then {
    policer ef-policer;
    forwarding-class ef-class;
  }
}
term network-control {
  from {
    precedence net-control;
  }
  then forwarding-class nc-class;
}
  term best-effort {
  then forwarding-class be-class;
}
```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

Confirm that the configuration is working properly.

- [Verifying a Firewall Filter for a Multifield Classifier Configuration on page 93](#)

### Verifying a Firewall Filter for a Multifield Classifier Configuration

---

**Purpose** Verify that a firewall filter for a multifield classifier is configured properly on a device.

**Action** From configuration mode, enter the **show firewall filter mf-classifier** command.

- Related Documentation**
- [Junos OS Routing Protocols and Policies Configuration Guide for Security Devices](#)
  - [Junos OS Firewall Filter and Policers Configuration Guide](#)
  - [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
  - [Example: Configuring a Two-Rate Three-Color Policers on page 84](#)



## CHAPTER 8

# Strict-Priority Queues

- [Strict-Priority Queue Overview on page 95](#)
- [Understanding Strict-Priority Queues on page 96](#)
- [Example: Configuring Priority Scheduling on page 97](#)
- [Example: Configuring Strict-Priority Queuing on page 99](#)

### Strict-Priority Queue Overview

---



**NOTE:** This topic applies only to J Series and SRX210, SRX240, and SRX650 devices.

You can configure one queue per interface to have strict-priority, which causes delay-sensitive traffic, such as voice traffic, to be removed and forwarded with minimum delay. Packets that are queued in a strict-priority queue are removed before packets in other queues, including high-priority queues.

The strict-high-priority queuing feature allows you to configure traffic policing that prevents lower priority queues from being starved. The strict-priority queue does not cause starvation of other queues because the configured policer allows the queue to exceed the configured bandwidth only when other queues are not congested. If the interface is congested, the software directs strict-priority queues to the configured bandwidth.

To prevent queue starvation of other queues, you must configure an output (egress) policer that defines a limit for the amount of traffic that the queue can service. The software services all traffic in the strict-priority queue that is under the defined limit. When strict-priority traffic exceeds the limit, the policer marks the traffic in excess of the limit as out-of-profile. If the output port is congested, the software drops out-of-profile traffic.

You can also configure a second policer with an upper limit. When strict-priority traffic exceeds the upper limit, the software drops the traffic in excess of the upper limit, regardless of whether the output port is congested. This upper-limit policer is not a requirement for preventing starvation of the lower priority queues. The policer for the lower limit, which marks the packets as out-of-profile, is sufficient to prevent starvation of other queues.

- Related Documentation**
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
  - [Understanding Strict-Priority Queues on page 96](#)
  - [Example: Configuring Priority Scheduling on page 97](#)
  - [Example: Configuring Strict-Priority Queuing on page 99](#)

---

## Understanding Strict-Priority Queues

You use strict-priority queuing and policing as follows:

- Identify delay-sensitive traffic by configuring a behavior aggregate (BA) or multifield (MF) classifier.
- Minimize delay by assigning all delay-sensitive packets to the strict-priority queue.
- Prevent starvation on other queues by configuring a policer that checks the data stream entering the strict-priority queue. The policer defines a lower bound, marks the packets that exceed the lower bound as out-of-profile, and drops the out-of-profile packets if the physical interface is congested. If there is no congestion, the software forwards all packets, including the out-of-profile packets.
- Optionally, configure another policer that defines an upper bound and drops the packets that exceed the upper bound, regardless of congestion on the physical interface.

To configure strict-priority queuing and prevent starvation of other queues, include the **priority strict-high** statement at the **[edit class-of-service schedulers *scheduler-name*]** hierarchy level and the **if-exceeding** and **then out-of-profile** statements at the **[edit firewall policer *policer-name*]** hierarchy level:

```
[edit class-of-service schedulers scheduler-name]  
priority strict-high;
```

```
[edit firewall policer policer-name]  
if-exceeding {  
    bandwidth-limit bps;  
    bandwidth-percent number;  
    burst-size-limit bytes;  
}  
then out-of-profile;
```

- Related Documentation**
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
  - [Strict-Priority Queue Overview on page 95](#)
  - [Example: Configuring Priority Scheduling on page 97](#)
  - [Example: Configuring Strict-Priority Queuing on page 99](#)



## Example: Configuring Priority Scheduling

This example shows how to configure priority scheduling so important traffic receives better access to the outgoing interface.

- [Requirements on page 97](#)
- [Overview on page 97](#)
- [Configuration on page 97](#)
- [Verification on page 98](#)

### Requirements

Before you begin, review how to create and configure forwarding classes. See [“Example: Configuring Forwarding Classes” on page 35](#).

### Overview

In this example, you configure CoS and a scheduler called be-sched with a medium-low priority. Then you configure scheduler map be-map to associate be-sched with the best-effort forwarding class. Finally, you apply be-map to interface ge-0/0/0.

### Configuration

#### CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service schedulers be-sched priority medium-low
set class-of-service scheduler-maps be-map forwarding-class best-effort scheduler
be-sched
set class-of-service interfaces ge-0/0/0 scheduler-map be-map
```

#### Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see [Using the CLI Editor in Configuration Mode in the \*Junos OS CLI User Guide\*](#).

To configure priority scheduling:

1. Configure CoS and a scheduler.
 

```
[edit]
user@host# edit class-of-service
user@host# edit schedulers be-sched
```
2. Set a priority.
 

```
[edit class-of-service schedulers be-sched]
user@host# set priority medium-low
```
3. Configure a scheduler map.
 

```
[edit]
user@host# edit class-of-service
```

```
user@host# edit scheduler-maps be-map
```

4. Specify the best-effort forwarding class.

```
[edit class-of-service scheduler-maps be-map]  
user@host# set forwarding-class best-effort scheduler be-sched
```

5. Apply best-effort map to an interface.

```
[edit]  
user@host# edit class-of-service  
user@host# set interfaces ge-0/0/0 scheduler-map be-map
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]  
user@host# show class-of-service  
interfaces {  
  ge-0/0/0 {  
    scheduler-map be-map;  
  }  
}  
scheduler-maps {  
  be-map {  
    forwarding-class best-effort scheduler be-sched;  
  }  
}  
schedulers {  
  be-sched {  
    priority medium-low;  
  }  
}
```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

Confirm that the configuration is working properly.

- [Verifying Priority Scheduling on page 98](#)

---

### Verifying Priority Scheduling

**Purpose** Verify that the priority scheduling is configured properly on a device.

**Action** From configuration mode, enter the **show class-of-service** command.

**Related Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Strict-Priority Queue Overview on page 95](#)
- [Understanding Strict-Priority Queues on page 96](#)
- [Example: Configuring Strict-Priority Queuing on page 99](#)

## Example: Configuring Strict-Priority Queuing

---

This example shows how to configure strict-priority queuing and prevent starvation of other queues.

- [Requirements on page 99](#)
- [Overview on page 99](#)
- [Configuration on page 99](#)
- [Verification on page 107](#)

### Requirements

Before you begin, review how to create and configure forwarding classes. See [“Example: Configuring Forwarding Classes” on page 35](#).

### Overview

In this example, you create a BA classifier to classify traffic based on the IP precedence of the packet. The classifier defines IP precedence value 101 as voice traffic and 000 as data traffic. You assign forwarding-class priority queue 0 to voice traffic and queue 1 as data traffic. You then configure the scheduler map as corp-map and voice scheduler as voice-sched.

Then you set the priority for the voice traffic scheduler as strict-high and for the data traffic scheduler as strict-low. You apply the BA classifier to input interface ge-0/0/0 and apply the scheduler map to output interface e1-1/0/0. You then configure two policers called voice-drop and voice-excess. You set the burst size limit and bandwidth limit for voice-drop policer and for voice-excess policer. You then create a firewall filter that includes the new policers and add the policer to the term.

Finally, you apply the filter to output interface e1-1/0/1 and set the IP address as 11.1.1.1/24.

### Configuration

- [Configuring a BA Classifier on page 99](#)
- [Configuring Forwarding Classes on page 100](#)
- [Configuring a Scheduler Map on page 101](#)
- [Configuring a Scheduler on page 102](#)
- [Applying a BA Classifier to an Input Interface on page 103](#)
- [Applying a Scheduler Map to an Output Interface on page 103](#)
- [Configuring Two Policers on page 104](#)
- [Applying a Filter to an Output Interface on page 106](#)

---

#### Configuring a BA Classifier

##### CLI Quick Configuration

To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your

network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service classifiers inet-precedence corp-traffic forwarding-class voice-class
  loss-priority low code-points 101
set class-of-service classifiers inet-precedence corp-traffic forwarding-class data-class
  loss-priority high code-points 000
```

#### Step-by-Step Procedure

To configure a BA classifier:

1. Create a BA classifier and set the IP precedence value for voice traffic.  
  
[edit]  
user@host# edit class-of-service classifiers inet-precedence corp-traffic  
                  forwarding-class voice-class loss-priority low  
user@host# set code-points 101
2. Create a BA classifier and set the IP precedence value for data traffic.  
  
[edit]  
user@host# edit class-of-service classifiers inet-precedence corp-traffic  
                  forwarding-class data-class loss-priority high  
user@host# set code-points 000

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service
classifiers {
  inet-precedence corp-traffic {
    forwarding-class voice-class {
      loss-priority low code-points 101;
    }
    forwarding-class data-class {
      loss-priority high code-points 000;
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

---

### Configuring Forwarding Classes

#### CLI Quick Configuration

To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service forwarding-classes queue 0 voice-class
set class-of-service forwarding-classes queue 1 data-class
```

<b>Step-by-Step Procedure</b>	<p>To configure forwarding classes:</p> <ol style="list-style-type: none"> <li>1. Assign priority queuing to voice traffic.           <pre>[edit] user@host# set class-of-service forwarding-classes queue 0 voice-class</pre> </li> <li>2. Assign priority queuing to data traffic.           <pre>[edit] user@host# set class-of-service forwarding-classes queue 1 data-class</pre> </li> </ol>
<b>Results</b>	<p>From configuration mode, confirm your configuration by entering the <b>show class-of-service</b> command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.</p> <pre>[edit] user@host# show class-of-service forwarding-classes {   queue 0 voice-class;   queue 1 data-class; }</pre> <p>If you are done configuring the device, enter <b>commit</b> from configuration mode.</p>

### Configuring a Scheduler Map

<b>CLI Quick Configuration</b>	<p>To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the <b>[edit]</b> hierarchy level.</p> <pre>set class-of-service scheduler-maps corp-map forwarding-class voice-class scheduler voice-sched set class-of-service scheduler-maps corp-map forwarding-class data-class scheduler data-sched</pre>
<b>Step-by-Step Procedure</b>	<p>To configure a scheduler map:</p> <ol style="list-style-type: none"> <li>1. Configure a scheduler map and voice scheduler.           <pre>[edit] user@host# edit class-of-service scheduler-maps corp-map forwarding-class voice-class user@host# set scheduler voice-sched</pre> </li> <li>2. Configure a scheduler map and data scheduler.           <pre>[edit] user@host# edit class-of-service scheduler-maps corp-map forwarding-class data-class user@host# set scheduler data-sched</pre> </li> </ol>
<b>Results</b>	<p>From configuration mode, confirm your configuration by entering the <b>show class-of-service</b> command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.</p>

```
[edit]
user@host# show class-of-service
scheduler-maps {
  corp-map {
    forwarding-class voice-class scheduler voice-sched;
    forwarding-class data-class scheduler data-sched;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

### Configuring a Scheduler

---

**CLI Quick Configuration** To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service schedulers voice-sched priority strict-high
set class-of-service schedulers data-sched priority lowset xxx
```

**Step-by-Step Procedure** To configure schedulers:

1. Configure a voice traffic scheduler and set the priority.

```
[edit]
user@host# edit class-of-service schedulers voice-sched
user@host# set priority strict-high
```

2. Configure a data traffic scheduler and set the priority.

```
[edit]
user@host# edit class-of-service schedulers data-sched
user@host# set priority low
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service
schedulers {
  voice-sched {
    priority strict-high;
  }
  data-sched {
    priority low;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

### Applying a BA Classifier to an Input Interface

**CLI Quick Configuration** To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service interfaces ge-0/0/0 unit 0 classifiers inet-precedence corp-traffic
```

**Step-by-Step Procedure** The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see *Using the CLI Editor in Configuration Mode* in the [Junos OS CLI User Guide](#).

To apply a BA classifier to an input interface:

1. Configure an interface.

```
[edit]
user@host# edit class-of-service interfaces ge-0/0/0 unit 0
```

2. Apply a BA classifier to an input interface.

```
[edit class-of-service interfaces ge-0/0/0 unit 0]
user@host# set classifiers inet-precedence corp-traffic
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service interfaces** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service interfaces
ge-0/0/0 {
  unit 0 {
    classifiers {
      inet-precedence corp-traffic;
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

### Applying a Scheduler Map to an Output Interface

**CLI Quick Configuration** To quickly configure this section of the example, copy the following command, paste it into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the command into the CLI at the **[edit]** hierarchy level.

```
set class-of-service interfaces e1-1/0/0 unit 0 scheduler-map corp-map
```

**Step-by-Step Procedure** The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the [Junos OS CLI User Guide](#).

To apply the scheduler map to an output interface:

1. Configure an interface.  

```
[edit]
user@host# edit class-of-service interfaces e1-1/0/0 unit 0
```
2. Apply a scheduler map to an output interface.  

```
[edit class-of-service interfaces e1-1/0/0 unit 0]
user@host# set scheduler-map corp-map
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service
interfaces {
  e1-1/0/0 {
    unit 0 {
      scheduler-map corp-map;
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

---

### Configuring Two Policers

---

**CLI Quick Configuration** To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set firewall policer voice-drop if-exceeding burst-size-limit 200000 bandwidth-limit
2000000
set firewall policer voice-drop then discard
set firewall policer voice-excess if-exceeding burst-size-limit 200000 bandwidth-limit
1000000
set firewall policer voice-excess then out-of-profile
set firewall filter voice-term term 01 from forwarding-class voice-class
set firewall filter voice-term term 01 then policer voice-drop next term
set firewall filter voice-term term 02 from forwarding-class voice-class
set firewall filter voice-term term 02 then policer voice-excess accept
```

**Step-by-Step Procedure** To configure two policers:

1. Configure a policer voice drop.  

```
[edit]
user@host# edit firewall policer voice-drop
```



```

user@host# set if-exceeding burst-size-limit 200000 bandwidth-limit 2000000
user@host# set then discard

```

2. Configure a policer voice excess.

```

[edit]
user@host# edit firewall policer voice-excess
user@host# set if-exceeding burst-size-limit 200000 bandwidth-limit 1000000
user@host# set then out-of-profile

```

3. Create a firewall filter that includes the new policers.

```

[edit]
user@host# edit firewall filter voice-term term 01
user@host# set from forwarding-class voice-class
user@host# set then policer voice-drop next term

```

4. Add the policer to the term.

```

[edit]
user@host# edit firewall filter voice-term term 02
user@host# set from forwarding-class voice-class
user@host# set then policer voice-excess accept

```

**Results** From configuration mode, confirm your configuration by entering the **show firewall** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```

[edit]
user@host# show firewall
policer voice-drop {
  if-exceeding {
    bandwidth-limit 2m;
    burst-size-limit 200k;
  }
  then discard;
}
policer voice-excess {
  if-exceeding {
    bandwidth-limit 1m;
    burst-size-limit 200k;
  }
  then out-of-profile;
}
filter voice-term {
  term 01 {
    from {
      forwarding-class voice-class;
    }
    then {
      policer voice-drop;
      next term;
    }
  }
  term 02 {
    from {
      forwarding-class voice-class;
    }
  }
}

```

```
    }
    then {
      policer voice-excess;
      accept;
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

---

### Applying a Filter to an Output Interface

#### CLI Quick Configuration

To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set interfaces e1-1/0/1 unit 0 family inet filter output voice-term
set interfaces e1-1/0/1 unit 0 family inet address 11.1.1.1/24
```

#### Step-by-Step Procedure

To apply a filter to an output interface:

1. Apply a filter to an interface.

```
[edit]
user@host# edit interfaces e1-1/0/1 unit 0 family inet filter output
user@host# set voice-term
```

2. Set an IP address.

```
[edit]
user@host# set interfaces e1-1/0/1 unit 0 family inet address 11.1.1.1/24
```

#### Results

From configuration mode, confirm your configuration by entering the **show interfaces** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show interfaces
e1-1/0/1 {
  unit 0 {
    family inet {
      filter {
        output voice-term;
      }
      address 11.1.1.1/24;
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

Confirm that the configuration is working properly.

- [Verifying the Scheduler Map on page 107](#)
- [Verifying the Interfaces on page 107](#)
- [Verifying the Interface Queues on page 107](#)

---

### Verifying the Scheduler Map

**Purpose** Verify that the scheduler map is configured properly.

**Action** From operational mode, enter the **show class-of-service scheduler-map corp-map** command.

---

### Verifying the Interfaces

**Purpose** Verify that the interfaces are configured properly.

**Action** From configuration mode, enter the **show interfaces** command.

---

### Verifying the Interface Queues

**Purpose** Verify that the interface queues are configured properly.

**Action** From configuration mode, enter the **show interfaces queue** command.

**Related Documentation**

- [Junos OS Interfaces Configuration Guide for Security Devices](#)
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Strict-Priority Queue Overview on page 95](#)
- [Understanding Strict-Priority Queues on page 96](#)
- [Example: Configuring Priority Scheduling on page 97](#)



## CHAPTER 9

# RED Drop Profiles

This section contains the following topics:

- [RED Drop Profiles Overview on page 109](#)
- [RED Drop Profiles and Congestion Control on page 110](#)
- [Configuring RED Drop Profiles on page 112](#)

## RED Drop Profiles Overview

---

A drop profile is a feature of the random early detection (RED) process that allows packets to be dropped before queues are full. Drop profiles are composed of two main values—the queue fullness and the drop probability. The queue fullness represents percentage of memory used to store packets in relation to the total amount that has been allocated for that queue. The drop probability is a percentage value that correlates to the likelihood that an individual packet is dropped from the network. These two variables are combined in a graph-like format.

When a packet reaches the head of the queue, a random number between 0 and 100 is calculated by the device. This random number is plotted against the drop profile having the current queue fullness of that particular queue. When the random number falls above the graph line, the packet is transmitted onto the physical media. When the number falls below the graph line, the packet is dropped from the network.

When you configure the RED drop profile on an interface, the queue no longer drops packets from the tail of the queue (the default). Rather, packets are dropped after they reach the head of the queue.

You specify drop probabilities in the drop profile section of the class-of-service (CoS) configuration hierarchy and reference them in each scheduler configuration. For each scheduler, you can configure multiple separate drop profiles, one for each combination of loss priority (low, medium-low, medium-high, or high) and IP transport protocol (TCP or non-TCP or any).



**NOTE:** For J Series devices and SRX210, SRX240, and SRX650 devices, tcp and non-tcp values are not supported, only the value “any” is supported.

---

You can configure a maximum of 32 different drop profiles.

To configure RED drop profiles, include the following statements at the **[edit class-of-service]** hierarchy level of the configuration:

```
[edit class-of-service]
drop-profiles {
  profile-name {
    fill-level percentage drop-probability percentage;
    interpolate {
      drop-probability [ values ];
      fill-level [ values ];
    }
  }
}
```

## Default Drop Profiles

By default, if you configure no drop profiles, RED is still in effect and functions as the primary mechanism for managing congestion. In the default RED drop profile, when the fill level is 0 percent, the drop probability is 0 percent. When the fill level is 100 percent, the drop probability is 100 percent.

- Related Documentation**
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
  - Example: Configuring RED Drop Profiles

## RED Drop Profiles and Congestion Control

If the device must support assured forwarding, you can control congestion by configuring random early detection (RED) drop profiles. RED drop profiles use drop probabilities for different levels of buffer fullness to determine which scheduling queue on the device is likely to drop assured forwarding packets under congested conditions. The device can drop packets when the queue buffer becomes filled to the configured percentage.

Assured forwarding traffic with the PLP (packet loss priority) bit set is more likely to be discarded than traffic without the PLP bit set. This example shows how to configure a drop probability and a queue fill level for both PLP and non-PLP assured forwarding traffic. It is only one example of how to use RED drop profiles.

The example shows how to configure the RED drop profiles listed in [Table 31 on page 110](#).

**Table 31: Sample RED Drop Profiles**

Drop Profile	Drop Probability	Queue Fill Level
<b>af-normal</b> —For non-PLP (normal) assured forwarding traffic	Between 0 (never dropped) and 100 percent (always dropped)	Between 95 and 100 percent
<b>af-with-plp</b> —For PLP (aggressive packet dropping) assured forwarding traffic	Between 95 and 100 percent (always dropped)	Between 80 and 95 percent

To configure RED drop profiles for assured forwarding congestion control on the device:

1. Navigate to the top of the configuration hierarchy in either the J-Web or CLI configuration editor.
2. Perform the configuration tasks described in [Table 32 on page 111](#).
3. If you are finished configuring the device, commit the configuration.
4. Go on to one of the following tasks:
  - To assign resources, priorities, and profiles to output queues, see [“Example: Configuring Class-of-Service Schedulers” on page 49](#).
  - To apply rules to logical interfaces, see [“Example: Configuring Virtual Channels” on page 149](#).
  - To use adaptive shapers to limit bandwidth for Frame Relay, see [“Example: Configuring and Applying an Adaptive Shaper” on page 117](#).

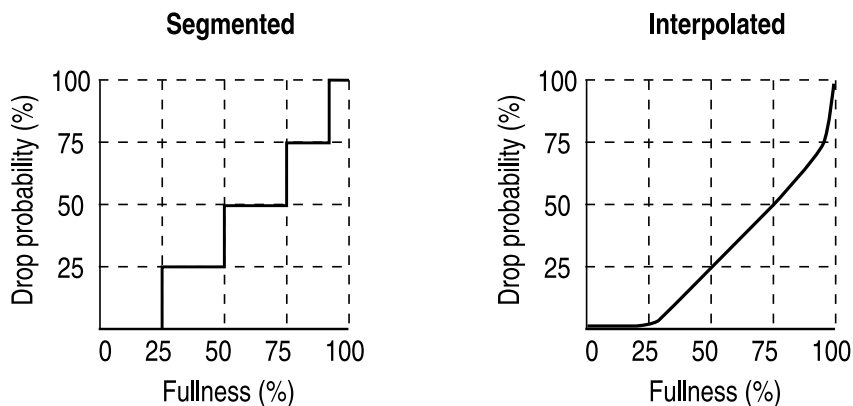
**Table 32: Configuring RED Drop Profiles for Assured Forwarding Congestion Control**

Task	CLI Configuration Editor
Navigate to the <b>Class of service</b> level in the configuration hierarchy.	From the <b>[edit]</b> hierarchy level, enter <b>edit class-of-service</b>
Configure the lower drop probability for normal, non-PLP traffic.	Enter <b>edit drop-profiles af-normal interpolate</b> <b>set drop-probability 0</b> <b>set drop-probability 100</b>
Configure a queue fill level for the lower non-PLP drop probability.	Enter <b>set fill-level 95</b> <b>set fill-level 100</b>
Configure the higher drop probability for PLP traffic.	From the <b>[edit class of service]</b> hierarchy level, enter <b>edit drop-profiles af-with-PLP interpolate</b> <b>set drop-probability 95</b> <b>set drop-probability 100</b>
Configure a queue fill level for the higher PLP drop probability.	Enter <b>set fill-level 80</b> <b>set fill-level 95</b>

## Configuring RED Drop Profiles

Create a segmented configuration and an interpolated configuration that correspond to the graphs in [Figure 3 on page 112](#). The values defined in the configuration are matched to represent the data points in the graph line. In this example, the drop probability is 25 percent when the queue is 50 percent full. The drop probability increases to 50 percent when the queue is 75 percent full.

**Figure 3: Segmented and Interpolated Drop Profiles**



**Segmented**

```

class-of-service {
  drop-profiles {
    segmented-style-profile {
      fill-level 25 drop-probability 25;
      fill-level 50 drop-probability 50;
      fill-level 75 drop-probability 75;
      fill-level 95 drop-probability 100;
    }
  }
}

```

To create the profile's graph line, the software begins at the bottom-left corner, representing a 0 percent fill level and a 0 percent drop probability. This configuration draws a line directly to the right until it reaches the first defined fill level, 25 percent for this configuration. The software then continues the line vertically until the first drop probability is reached. This process is repeated for all of the defined levels and probabilities until the top-right corner of the graph is reached.

Create a smoother graph line by configuring the profile with the **interpolate** statement. This allows the software to automatically generate 64 data points on the graph beginning at (0, 0) and ending at (100, 100). Along the way, the graph line intersects specific data points, which you define as follows:

**Interpolated**

```

class-of-service {
  drop-profiles {
    interpolated-style-profile {
      interpolate {
        fill-level [ 50 75 ];
        drop-probability [ 25 50 ];
      }
    }
  }
}

```

1704



```
    }  
  }  
}
```



## CHAPTER 10

# Adaptive Shapers for Frame Relay

- [Adaptive Shaping Overview on page 115](#)
- [Classifying Frame Relay Traffic on page 116](#)
- [Example: Configuring and Applying an Adaptive Shaper on page 117](#)

## Adaptive Shaping Overview

---

You can use adaptive shaping to limit the bandwidth of traffic flowing on a Frame Relay logical interface. If you configure and apply adaptive shaping, the device checks the backward explicit congestion notification (BECN) bit within the last inbound (ingress) packet received on the interface.



**NOTE:** Adaptive shaping is not available on SRX210, SRX240, SRX650, SRX1400, SRX3400, SRX3600, SRX5600, and SRX5800 devices.

To configure an adaptive shaper, include the **adaptive-shaper** statement at the [edit class-of-service] hierarchy level:

```
[edit class-of-service]
adaptive-shaper {
  adaptive-shaper-name {
    trigger type shaping-rate (percent percentage | rate);
  }
}
```

The trigger type can be **BECN** only. If the last ingress packet on the logical interface has its BECN bit set to 1, the output queues on the logical interface are shaped according to the associated shaping rate.

The associated shaping rate can be a percentage of the available interface bandwidth from 0 through 100 percent. Alternatively, you can configure the shaping rate to be an absolute peak rate, in bits per second (bps) from 3200 through 32,000,000,000 bps. You can specify the value either as a complete decimal number or as a decimal number followed by the abbreviation **K** (1000), **M** (1,000,000), or **G** (1,000,000,000).

### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Assigning the Default Frame Relay Loss Priority Map to an Interface on page 116](#)

- [Defining a Custom Frame Relay Loss Priority Map on page 116](#)
- [Example: Configuring and Applying an Adaptive Shaper on page 117](#)

## Classifying Frame Relay Traffic

---

This section contains the following topics:

- [Assigning the Default Frame Relay Loss Priority Map to an Interface on page 116](#)
- [Defining a Custom Frame Relay Loss Priority Map on page 116](#)

### Assigning the Default Frame Relay Loss Priority Map to an Interface

For J Series and SRX210, SRX240, and SRX650 device interfaces with Frame Relay encapsulation, you can set the loss priority of Frame Relay traffic based on the discard eligibility (DE) bit. For each incoming frame with the DE bit containing the CoS value 0 or 1, you can configure a Frame Relay loss priority value of low, medium-low, medium-high, or high.

The default Frame Relay loss priority map contains the following settings:

```
loss-priority low code-point 0;  
loss-priority high code-point 1;
```

This default map sets the loss priority to low for each incoming frame with the DE bit containing the 0 CoS value. The map sets the loss priority to high for each incoming frame with the DE bit containing the 1 CoS value.

To assign the default map to an interface, include the **frame-relay-de default** statement at the [edit class-of-service interfaces *interface-name* unit *logical-unit-number* loss-priority-maps] hierarchy level:

```
[edit class-of-service interfaces interface-name unit logical-unit-number loss-priority-maps]  
frame-relay-de default;
```

### Defining a Custom Frame Relay Loss Priority Map

You can apply a classifier to the same interface on which you configure a Frame Relay loss priority value. The Frame Relay loss priority map is applied first, followed by the classifier. The classifier can change the loss priority to a higher value only (for example, from low to high). If the classifier specifies a loss priority with a lower value than the current loss priority of a particular packet, the classifier does not change the loss priority of that packet.

To define a custom Frame Relay loss priority map, include the following statements at the [edit class-of-service] hierarchy level:

```
[edit class-of-service]  
loss-priority-maps {  
  frame-relay-de map-name {  
    loss-priority (low | medium-low | medium-high | high) code-point (0 | 1);  
  }  
}
```

A custom loss priority map sets the loss priority to low, medium-low, medium-high, or high for each incoming frame with the DE bit containing the specified 0 or 1 CoS value.

The map does not take effect until you apply it to a logical interface. To apply a map to a logical interface, include the **frame-relay-de *map-name*** statement at the [edit class-of-service interfaces *interface-name* unit *logical-unit-number* loss-priority-maps] hierarchy level:

```
[edit class-of-service interfaces interface-name unit logical-unit-number loss-priority-maps]
frame-relay-de map-name;
```

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Adaptive Shaping Overview on page 115](#)
- [Example: Configuring and Applying an Adaptive Shaper on page 117](#)

## Example: Configuring and Applying an Adaptive Shaper

This example shows how to configure and apply an adaptive shaper to limit the bandwidth of traffic on a Frame Relay logical interface.

- [Requirements on page 117](#)
- [Overview on page 117](#)
- [Configuration on page 117](#)
- [Verification on page 118](#)

### Requirements

Before you begin, review how to create and apply scheduler maps. See “[Example: Configuring and Applying Scheduler Maps](#)” on page 63

### Overview

In this example, you create adaptive shaper fr-shaper and apply it to T1 interface t1-0/0/2. The adapter shaper limits the transmit bandwidth on the interface to 64 Kbps.

### Configuration

#### Step-by-Step Procedure

The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the [Junos OS CLI User Guide](#).

To configure and apply an adaptive shaper to a logical interface:

1. Specify the name and the maximum transmit rate of the adaptive shaper.
 

```
[edit]
user@host# edit class-of-service
user@host# set adaptive-shapers fr-shaper trigger becn shaping-rate 64k
```
2. Apply the adaptive shaper to the logical interface.
 

```
[edit class-of-service]
```

```
user@host# set interfaces t1-0/0/2 unit 0 adaptive-shaper fr-shaper
```

3. If you are done configuring the device, commit the configuration.

```
[edit]  
user@host# commit
```

## Verification

To verify the configuration is working properly, enter the **show class-of-service** command.

### Related Documentation

- [Junos OS System Basics and Services Command Reference](#)
- [Junos OS Interfaces Configuration Guide for Security Devices](#)
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Adaptive Shaping Overview on page 115](#)
- [Assigning the Default Frame Relay Loss Priority Map to an Interface on page 116](#)
- [Defining a Custom Frame Relay Loss Priority Map on page 116](#)

## PART 3

# Class of Service and Hierarchical Schedulers

- [Hierarchical Schedulers Overview on page 121](#)





## CHAPTER 11

# Hierarchical Schedulers Overview

- [Understanding Hierarchical Schedulers on page 121](#)
- [SRX1400, SRX3400, and SRX3600 Device Hardware Capabilities and Limitations on page 124](#)
- [Example: Configuring a Scheduler Hierarchy on page 126](#)
- [Example: Controlling Remaining Traffic on page 138](#)
- [Understanding Internal Scheduler Nodes on page 143](#)

## Understanding Hierarchical Schedulers

Hierarchical schedules consist of nodes and queues. Queues terminate the CLI hierarchy. Nodes can be either root nodes, leaf nodes, or internal (non-leaf) nodes. Internal nodes are nodes that have other nodes as “children” in the hierarchy. For example, if an **interface-set** statement is configured with a logical interface (such as unit 0) and queue, then the **interface-set** is an internal node at level 2 of the hierarchy. However, if there are no traffic control profiles configured on logical interfaces, then the interface set is at level 3 of the hierarchy.

[Table 33 on page 121](#) shows how the configuration of an interface set or logical interface affects the terminology of hierarchical scheduler nodes.

**Table 33: Hierarchical Scheduler Nodes**

Root Node (Level 1)	Internal Node (Level 2)	Leaf Node (Level 3)	Queue (Level 4)
Physical interface	Interface set	Logical interfaces	One or more queues
Physical interface	—	Interface set	One or more queues
Physical interface	—	Logical interfaces	One or more queues

When used, the interface set level of the hierarchy falls between the physical interface level (level 1) and the logical interface (level 3). Queues are always level 4 of the hierarchy. The schedulers hold the information about the queues, the last level of the hierarchy. In all cases, the properties for level 4 of the hierarchical schedulers are determined by the scheduler map.

Hierarchical schedulers add CoS parameters to the new interface set level of the configuration. They use traffic control profiles to set values for parameters such as shaping rate (the peak information rate [PIR]), guaranteed rate (the committed information rate [CIR] on these interfaces), and scheduler maps (the queues and resources assigned to traffic).

The following CoS configuration places the following parameters in traffic control profiles at various levels:

- Traffic control profile at the port level (**tcp-port-level1**):
  - A shaping rate (PIR) of 100 Mbps
  - A delay buffer rate of 100 Mbps
- Traffic control profile at the interface set level (**tcp-interface-level2**):
  - A shaping rate (PIR) of 60 Mbps
  - A guaranteed rate (CIR) of 40 Mbps
- Traffic control profile at the logical interface level (**tcp-unit-level3**):
  - A shaping rate (PIR) of 50 Mbps
  - A guaranteed rate (CIR) of 30 Mbps
  - A scheduler map called `smap1` to hold various queue properties (level 4)
  - A delay buffer rate of 40 Mbps

In this case, the traffic control profiles look like this:

```
[edit class-of-service traffic-control-profiles]
tcp-port-level1 { # This is the physical port level
  shaping-rate 100m;
  delay-buffer-rate 100m;
}
tcp-interface-level2 { # This is the interface set level
  shaping-rate 60m;
  guaranteed-rate 40m;
}
tcp-unit-level3 { # This is the logical interface level
  shaping-rate 50m;
  guaranteed-rate 30m;
  scheduler-map smap1;
  delay-buffer-rate 40m;
}
```

Once configured, the traffic control profiles must be applied to the proper places in the CoS interfaces hierarchy.

```
[edit class-of-service interfaces]
interface-set level-2 {
  output-traffic-control-profile tcp-interface-level-2;
}
ge-0/1/0 {
```

```

output-traffic-control-profile tcp-port-level-1;
unit 0 {
    output-traffic-control-profile tcp-unit-level-3;
}
}

```

Interface sets can be defined as a list of logical interfaces, for example, unit 100, unit 200, and so on. Service providers can use these statements to group interfaces to apply scheduling parameters such as guaranteed rate and shaping rate to the traffic in the groups. Interface sets are currently only used by CoS, but they are applied at the **[edit interfaces]** hierarchy level so that they might be available to other services.

All traffic heading downstream must be gathered into an interface set with the **interface-set** statement at the [edit class-of-service interfaces] hierarchy level.



**NOTE:** Ranges are not supported; you must list each logical interface separately.

Although the interface set is applied at the [edit interfaces] hierarchy level, the CoS parameters for the interface set are defined at the [edit class-of-service interfaces] hierarchy level, usually with the **output-traffic-control-profile** *profile-name* statement.

You cannot specify an interface set mixing the logical interface, S-VLAN, or VLAN outer tag list forms of the **interface-set** statement. A logical interface can only belong to one interface set. If you try to add the same logical interface to different interface sets, the commit will fail.

This example will generate a commit error:

```

[edit interfaces]
interface-set set-one {
    ge-2/0/0 {
        unit 0;
        unit 2;
    }
}
interface-set set-two {
    ge-2/0/0 {
        unit 1;
        unit 3;
        unit 0; # COMMIT ERROR! Unit 0 already belongs to -set-one.
    }
}

```

Members of an interface set cannot span multiple physical interfaces. Only one physical interface is allowed to appear in an interface set.

This configuration is not supported:

```

[edit interfaces]
interface-set set-group {
    ge-0/0/1 {
        unit 0;
    }
}

```

```

        unit 1;
    }
    ge-0/0/2 { # This type of configuration is NOT supported in the same interface set!
        unit 0;
        unit 1;
    }
}

```

You can configure many logical interfaces under an interface. However, only a subset of them might have a traffic control profile attached. For example, you can configure three logical interfaces (units) over the same service VLAN, but you can apply a traffic control profile specifying best-effort and voice queues to only one of the logical interface units. Traffic from the two remaining logical interfaces is considered *remaining traffic*.

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [SRX1400, SRX3400, and SRX3600 Device Hardware Capabilities and Limitations on page 124](#)
- [Example: Configuring a Scheduler Hierarchy on page 126](#)
- [Example: Controlling Remaining Traffic on page 138](#)
- [Understanding Internal Scheduler Nodes on page 143](#)

## SRX1400, SRX3400, and SRX3600 Device Hardware Capabilities and Limitations

For SRX1400, SRX3400, and SRX3600 devices, each Input/Output Card (IOC), Flexible PIC Concentrator (FPC), or IOC slot has only one Physical Interface Card (PIC), which contains either two 10-Gigabit Ethernet ports or sixteen 1-Gigabit Ethernet ports. [Table 34 on page 124](#) shows the maximum number of cards and ports allowed in SRX1400, SRX3400, and SRX3600 devices.



**NOTE:** The number of ports the Network Processing Unit (NPU) needs to handle may be different from the fixed 10:1 port to NPU ratio for 1-Gigabit IOC, or the 1:1 ratio for the 10-Gigabit IOC that is needed on the SRX5600 and SRX5800 devices, leading to oversubscription on the SRX1400, SRX3400, and SRX3600 devices.

**Table 34: Available NPCs and IO Ports for SRX1400, SRX3400, and SRX3600 Devices**

System	IOCs	IO Ports	NPCs
SRX3600	7	108 (16 x 6 + 12)	3
SRX3400	5	76 (16 x 4 + 12)	2
SRX1400	2	28 (16 x 1 + 12)	1

SRX3400 and SRX3600 devices allow you to install up to three Network Processing Cards (NPCs). In a single NPC configuration, the NPC has to process all of the packets

to and from each IOC. However, when there is more than one NPC available, an IOC will only exchange packets with a preassigned NPC. You can use the **set chassis ioc-npc-connectivity** CLI statement to configure the IOC-to-NPC mapping. By default, the mapping is assigned so that the load is shared equally among all NPCs. When the mapping is changed, for example, an IOC or NPC is removed, or you have mapped a specific NPC to an IOC, then the device has to be restarted.



**NOTE:** SRX1400 devices support a single NPC or an NSPC combo card.

For SRX1400, SRX3400, and SRX3600 devices, the IOC supports the following hierarchical scheduler characteristics:

- Level 1- Shaping at the physical interface (ifd)
- Level 2- Shaping and scheduling at the logical interface level (ifl)
- Level 3- Scheduling at the queue level



**NOTE:** Interface set (iflset) is not supported for SRX1400, SRX3400, and SRX3600 devices.

In SRX5600 and SRX5800 devices, an NPC supports 32 port-level shaping profiles at level 1, such that each front port can have its own shaping profile.

In SRX1400, SRX3400, and SRX3600 devices, an NPC supports only 16 port-level shaping profiles in the hardware, including two profiles that are predefined for 10-GB and 1-GB shaping rates. The user can configure up to 14 different levels of shaping rates. If more levels are configured, then the closest match found in the 16 profiles will be used instead.

For example, assume that a system is already configured with the following rates for ifd:

10 Mbps, 20 Mbps, 40 Mbps, 60 Mbps, 80 Mbps, 100 Mbps, 200 Mbps, 300 Mbps, 400 Mbps, 500 Mbps, 600 Mbps, 700 Mbps, 800 Mbps, 900 Mbps, 1 GB (predefined), 10 GB (predefined)

Each of these 16 rates is programmed into one of the 16 profiles in the hardware; then consider the following two scenarios:

- Scenario 1: If the user changes one port's shaping rate from 1 GB to 100 Mbps, which is already programmed in one of the 16 profiles, the profile with a 100 Mbps shaping rate will be used by the port.
- Scenario 2: If the user changes another port's shaping rate from 1 GB to 50 Mbps, which is not in the shaping profiles, the closest matching profile with a 60 Mbps shaping rate will be used instead.

When scenario 2 occurs, not all of the user-configured rates can be supported by the hardware. Even if more than 14 different rates are specified, only 14 will be programmed in the hardware. Which 14 rates are programmed in the hardware depends on many

factors. For this reason, we recommend that you plan carefully and use no more than 14 levels of port-level shaping rates.

Each device supports Weighed Random Early Discard (WRED) at the port level, and each NPU has 512 MB of frame memory. Also, 10-Gigabit Ethernet ports get more buffers than the 1-Gigabit Ethernet ports. Buffer availability depends on how much bandwidth (number of NPCs, ports, 1 GB or 10 GB, and so on) the device has to support. The more bandwidth that the device has to support, the less buffer is available. When two NPCs are available, the amount of frame buffer available is doubled.

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Understanding Hierarchical Schedulers on page 121](#)
- [Example: Configuring a Scheduler Hierarchy on page 126](#)
- [Example: Controlling Remaining Traffic on page 138](#)
- [Understanding Internal Scheduler Nodes on page 143](#)

---

## Example: Configuring a Scheduler Hierarchy

This example shows how to configure a 4-level hierarchy of schedulers.

- [Requirements on page 126](#)
- [Overview on page 126](#)
- [Configuration on page 127](#)
- [Verification on page 137](#)

### Requirements

Before you begin:

- Review how to configure schedulers. See [“Example: Configuring Class-of-Service Schedulers” on page 49](#).
- Review RED drop profiles. See [Understanding RED Drop Profiles](#).
- Review how to configure and apply scheduler maps. See [“Example: Configuring and Applying Scheduler Maps” on page 63](#).

### Overview

The configuration parameters for this example are shown in [Figure 4 on page 127](#). The queues are shown at the top of the figure with the other three levels of the hierarchy below.

Figure 4: Building a Scheduler Hierarchy

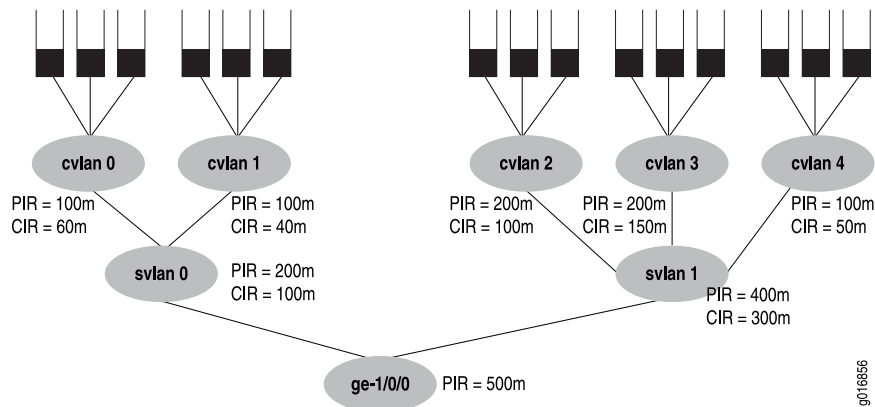


Figure 4 on page 127's PIR values will be configured as the shaping rates, and the CIRs will be configured as the guaranteed rate on the Ethernet interface **ge-1/0/0**. The PIR can be oversubscribed (that is, the sum of the children PIRs can exceed the parent's, as in **svlan 1**, where  $200 + 200 + 100$  exceeds the parent rate of 400). However, the sum of the children node level's CIRs must never exceed the parent node's CIR, as shown in all the service VLANs (otherwise, the guaranteed rate could never be provided in all cases).



**NOTE:** Although a shaping rate can be applied directly to the physical interface, hierarchical schedulers must use a traffic control profile to hold the shaping rate parameter.

The keyword to configure hierarchical schedulers is at the physical interface level, as are VLAN tagging and the VLAN IDs. In this example, the interface sets are defined by logical interfaces (units) and not outer VLAN tags. All VLAN tags in this example are customer VLAN tags.

The traffic control profiles in this example are for both the service VLAN level (logical interfaces) and the customer VLAN (VLAN tag) level.

This example shows all details of the CoS configuration for the **ge-1/0/0** interface in Figure 4 on page 127.

## Configuration

This section contains the following topics:

- [Configuring the Logical Interfaces on page 128](#)
- [Configuring the Interface Sets on page 129](#)
- [Applying an Interface Set on page 130](#)
- [Configuring the Traffic Control Profiles on page 130](#)
- [Configuring the Schedulers on page 132](#)
- [Configuring the Drop Profiles on page 133](#)

- [Configuring the Scheduler Maps on page 134](#)
- [Applying Traffic Control Profiles on page 136](#)

### Configuring the Logical Interfaces

---

#### CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
edit interface ge-1/0/0
set hierarchical-scheduler vlan-tagging unit 1 vlan-id 101
set hierarchical-scheduler vlan-tagging unit 1 vlan-id 101
set hierarchical-scheduler vlan-tagging unit 2 vlan-id 102
set hierarchical-scheduler vlan-tagging unit 3 vlan-id 103
set hierarchical-scheduler vlan-tagging unit 4 vlan-id 104
```

#### Step-by-Step Procedure

To configure the logical interfaces:

1. Create the logical interface.

```
[edit]
user@host# edit interface ge-1/0/0
```

2. Create the interface sets by defining the VLAN tagging and the VLAN IDs for each level.

```
[edit interface ge-1/0/0]
user@host# set hierarchical-scheduler vlan-tagging unit 0 vlan-id 100
user@host# set hierarchical-scheduler vlan-tagging unit 1 vlan-id 101
user@host# set hierarchical-scheduler vlan-tagging unit 2 vlan-id 102
user@host# set hierarchical-scheduler vlan-tagging unit 3 vlan-id 103
user@host# set hierarchical-scheduler vlan-tagging unit 4 vlan-id 104
```

#### Results

From configuration mode, confirm your configuration by entering the **show interface ge-1/0/0** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show interface ge-1/0/0
hierarchical-scheduler;
vlan-tagging;
unit 0 {
    vlan-id 100;
}
unit 1 {
    vlan-id 101;
}
unit 2 {
    vlan-id 102;
}
unit 3 {
    vlan-id 103;
}
unit 4 {
```



```
vlan-id 104;
}
```

If you are done configuring the device, enter **commit** from configuration mode.

### Configuring the Interface Sets

#### CLI Quick Configuration

To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service interfaces interface-set svlan-0 interface ge-1/0/0 unit 0
set class-of-service interfaces interface-set svlan-0 interface ge-1/0/0 unit 1
set class-of-service interfaces interface-set svlan-1 interface ge-1/0/0 unit 2
set class-of-service interfaces interface-set svlan-1 interface ge-1/0/0 unit 3
set class-of-service interfaces interface-set svlan-1 interface ge-1/0/0 unit 4
```

#### Step-by-Step Procedure

To configure the interface sets:

1. Create the first logical interface and its CoS parameters.

```
[edit class-of-service interfaces]
user@host# set interface-set svlan-0 interface ge-1/0/0 unit 0
user@host# set interface-set svlan-0 interface ge-1/0/0 unit 1
```

2. Create the second logical interface and its CoS parameters.

```
[edit class-of-service interfaces]
user@host# set interface-set svlan-1 interface ge-1/0/0 unit 2
user@host# set interface-set svlan-1 interface ge-1/0/0 unit 3
user@host# set interface-set svlan-1 interface ge-1/0/0 unit 4
```

#### Results

From configuration mode, confirm your configuration by entering the **show interfaces** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show interfaces
interface-set svlan-0 {
  interface ge-1/0/0 {
    unit 0;
    unit 1;
  }
}
interface-set svlan-1 {
  interface ge-1/0/0 {
    unit 2;
    unit 3;
    unit 4;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

### Applying an Interface Set

---

**CLI Quick Configuration** To quickly configure this section of the example, copy the following command, paste it into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the command into the CLI at the **[edit]** hierarchy level.

```
set class-of-service interfaces interface-set set-ge-0 output-traffic-control-profile tcp-set1
```

**Step-by-Step Procedure** To apply an interface set:

1. Create the Ethernet interface set.

```
[edit class-of-service interfaces]
user@host# set interface-set set-ge-0
```

2. Apply a traffic control parameter to the Ethernet interface set.

```
[edit class-of-service interfaces interface-set set-ge-0]
user@host# set output-traffic-control-profile tcp-set1
```

**Results** From configuration mode, confirm your configuration by entering the **show interfaces** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show interfaces
interface-set set-ge-0 {
    output-traffic-control-profile tcp-set1;
}
```

If you are done configuring the device, enter **commit** from configuration mode.

### Configuring the Traffic Control Profiles

---

**CLI Quick Configuration** To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service traffic-control-profiles tcp-500m-shaping-rate shaping-rate 500m
set class-of-service traffic-control-profiles tcp-svlan0 shaping-rate 200m guaranteed-rate
100m delay-buffer-rate 300m
set class-of-service traffic-control-profiles tcp-svlan1 shaping-rate 400m guaranteed-rate
30100m delay-buffer-rate 100m
set class-of-service traffic-control-profiles tcp-cvlan0 shaping-rate 100m guaranteed-rate
60m scheduler-map tcp-map-cvlan0
set class-of-service traffic-control-profiles tcp-cvlan1 shaping-rate 100m guaranteed-rate
40m scheduler-map tcp-map-cvlan1
set class-of-service traffic-control-profiles tcp-cvlan2 shaping-rate 200m guaranteed-rate
100m scheduler-map tcp-map-cvlanx
set class-of-service traffic-control-profiles tcp-cvlan3 shaping-rate 200m guaranteed-rate
150m scheduler-map tcp-map-cvlanx
```

```
set class-of-service traffic-control-profiles tcp-cvlan4 shaping-rate 100m guaranteed-rate
50m scheduler-map tcp-map-cvlanx
```

### Step-by-Step Procedure

To configure the traffic control profiles:

1. Create the traffic profile parameters.  

```
[edit class-of-service traffic-control-profiles]
user@host# tcp-500m-shaping-rate shaping-rate 500m
```
2. Create the traffic control profiles and parameters for the S-VLAN (logical interfaces) level.  

```
[edit class-of-service traffic-control-profiles]
user@host# set tcp-svlan0 shaping-rate 200m guaranteed-rate 100m
delay-buffer-rate 300m
user@host# set tcp-svlan1 shaping-rate 400m guaranteed-rate 30100m
delay-buffer-rate 100m
```
3. Create the traffic control profiles and parameters for the C-VLAN (VLAN tags) level.  

```
[edit class-of-service traffic-control-profiles]
user@host# set tcp-cvlan0 shaping-rate 100m guaranteed-rate 60m scheduler-map
tcp-map-cvlan0
user@host# set tcp-cvlan1 shaping-rate 100m guaranteed-rate 40m scheduler-map
tcp-map-cvlan1
user@host# set tcp-cvlan2 shaping-rate 200m guaranteed-rate 100m
scheduler-map tcp-map-cvlanx
user@host# set tcp-cvlan3 shaping-rate 200m guaranteed-rate 150m scheduler-map
tcp-map-cvlanx
user@host# set tcp-cvlan4 shaping-rate 100m guaranteed-rate 50m scheduler-map
tcp-map-cvlanx
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service traffic-control-profiles** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service traffic-control-profiles
tcp-500m-shaping-rate {
  shaping-rate 500m;
}
tcp-svlan0 {
  shaping-rate 200m;
  guaranteed-rate 100m;
  delay-buffer-rate 300m; # This parameter is not shown in the figure
}
tcp-svlan1 {
  shaping-rate 400m;
  guaranteed-rate 300m;
  delay-buffer-rate 100m; # This parameter is not shown in the figure
}
tcp-cvlan0 {
  shaping-rate 100m;
  guaranteed-rate 60m;
  scheduler-map tcp-map-cvlan0; # This example applies scheduler maps to customer
VLANs
```

```
}
tcp-cvlan1 {
    shaping-rate 100m;
    guaranteed-rate 40m;
    scheduler-map tcp-map-cvlan1; # This example applies scheduler maps to customer
    VLANs
}
tcp-cvlan2 {
    shaping-rate 200m;
    guaranteed-rate 100m;
    scheduler-map tcp-map-cvlanx; # This example applies scheduler maps to customer
    VLANs
}
tcp-cvlan3 {
    shaping-rate 200m;
    guaranteed-rate 150m;
    scheduler-map tcp-map-cvlanx; # This example applies scheduler maps to customer
    VLANs
}
tcp-cvlan4 {
    shaping-rate 100m;
    guaranteed-rate 50m;
    scheduler-map tcp-map-cvlanx; # This example applies scheduler maps to customer
    VLANs
}
```

If you are done configuring the device, enter **commit** from configuration mode.

---

### Configuring the Schedulers

#### CLI Quick Configuration

To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service schedulers sched-cvlan0-qx priority low transmit-rate 20m buffer-size
temporal 100ms drop-profile-map loss-priority low dp-low drop-profile-map loss-priority
high dp-high
set class-of-service schedulers sched-cvlan1-q0 priority high transmit-rate 20m buffer-size
percent 40 drop-profile-map loss-priority low dp-low drop-profile-map loss-priority
high dp-high
set class-of-service schedulers sched-cvlanx-qx transmit-rate percent 30 buffer-size
percent 30 drop-profile-map loss-priority low dp-low drop-profile-map loss-priority
high dp-high
set class-of-service schedulers sched-cvlan1-qx transmit-rate 10m buffer-size temporal
100ms drop-profile-map loss-priority low dp-low drop-profile-map loss-priority high
dp-high
```

#### Step-by-Step Procedure

To configure the schedulers:

1. Create the schedulers and their parameters.  
**[edit class-of-service schedulers]**

```

user@host# set sched-cvlan0-qx priority low transmit-rate 20m buffer-size temporal
100ms drop-profile-map loss-priority low dp-low drop-profile-map loss-priority
high dp-high
user@host# set sched-cvlan1-q0 priority high transmit-rate 20m buffer-size percent
40 drop-profile-map loss-priority low dp-low drop-profile-map loss-priority high
dp-high
user@host# set sched-cvlanx-qx transmit-rate percent 30 buffer-size percent 30
drop-profile-map loss-priority low dp-low drop-profile-map loss-priority high
dp-high
user@host# set sched-cvlan1-qx transmit-rate 10m buffer-size temporal 100ms
drop-profile-map loss-priority low dp-low drop-profile-map loss-priority high
dp-high

```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service schedulers** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```

[edit]
user@host# show class-of-service schedulers
sched-cvlan0-qx {
    priority low;
    transmit-rate 20m;
    buffer-size temporal 100ms;
    drop-profile-map loss-priority low dp-low;
    drop-profile-map loss-priority high dp-high;
}
sched-cvlan1-q0 {
    priority high;
    transmit-rate 20m;
    buffer-size percent 40;
    drop-profile-map loss-priority low dp-low;
    drop-profile-map loss-priority high dp-high;
}
sched-cvlanx-qx {
    transmit-rate percent 30;
    buffer-size percent 30;
    drop-profile-map loss-priority low dp-low;
    drop-profile-map loss-priority high dp-high;
}
sched-cvlan1-qx {
    transmit-rate 10m;
    buffer-size temporal 100ms;
    drop-profile-map loss-priority low dp-low;
    drop-profile-map loss-priority high dp-high;
}

```

If you are done configuring the device, enter **commit** from configuration mode.

### Configuring the Drop Profiles

#### CLI Quick Configuration

To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service drop-profiles dp-low interpolate fill-level 80 drop-probability 80
set class-of-service drop-profiles dp-low interpolate fill-level 100 drop-probability 100
set class-of-service drop-profiles dp-high interpolate fill-level 60 drop-probability 80
set class-of-service drop-profiles dp-high interpolate fill-level 80 drop-probability 100
```

#### Step-by-Step Procedure

To configure the drop profiles:

1. Create the low drop profile.

```
[edit class-of-service drop-profiles]
user@host# set dp-low interpolate fill-level 80 drop-probability 80
user@host# set dp-low interpolate fill-level 100 drop-probability 100
```

2. Create the high drop profile.

```
[edit class-of-service drop-profiles]
user@host# set dp-high interpolate fill-level 60 drop-probability 80
user@host# set dp-high interpolate fill-level 80 drop-probability 100
```

#### Results

From configuration mode, confirm your configuration by entering the **show class-of-service drop-profiles** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service drop-profiles
dp-low {
    interpolate fill-level 80 drop-probability 80;
    interpolate fill-level 100 drop-probability 100;
}
dp-high {
    interpolate fill-level 60 drop-probability 80;
    interpolate fill-level 80 drop-probability 100;
}
```

If you are done configuring the device, enter **commit** from configuration mode.

### Configuring the Scheduler Maps

#### CLI Quick Configuration

To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service scheduler-maps tcp-map-cvlan0 forwarding-class voice scheduler
  sched-cvlan0-qx
set class-of-service scheduler-maps tcp-map-cvlan0 forwarding-class video scheduler
  sched-cvlan0-qx
set class-of-service scheduler-maps tcp-map-cvlan0 forwarding-class data scheduler
  sched-cvlan0-qx
set class-of-service scheduler-maps tcp-map-cvlan1 forwarding-class voice scheduler
  sched-cvlan1-q0
set class-of-service scheduler-maps tcp-map-cvlan1 forwarding-class video scheduler
  sched-cvlan1-qx
set class-of-service scheduler-maps tcp-map-cvlan1 forwarding-class data scheduler
  sched-cvlan1-qx
```

```

set class-of-service scheduler-maps tcp-map-cvlanx forwarding-class voice scheduler
  sched-cvlanx-qx
set class-of-service scheduler-maps tcp-map-cvlanx forwarding-class video scheduler
  sched-cvlanx-qx
set class-of-service scheduler-maps tcp-map-cvlanx forwarding-class data scheduler
  sched-cvlanx-qx

```

### Step-by-Step Procedure

To configure three scheduler maps:

1. Create the first scheduler map.

```

[edit class-of-service scheduler-maps]
user@host# set tcp-map-cvlan0 forwarding-class voice scheduler sched-cvlan0-qx
user@host# set tcp-map-cvlan0 forwarding-class video scheduler sched-cvlan0-qx
user@host# set tcp-map-cvlan0 forwarding-class data scheduler sched-cvlan0-qx

```

2. Create the second scheduler map.

```

[edit class-of-service scheduler-maps]
user@host# set tcp-map-cvlan1 forwarding-class voice scheduler sched-cvlan1-q0
user@host# set tcp-map-cvlan1 forwarding-class video scheduler sched-cvlan1-qx
user@host# set tcp-map-cvlan1 forwarding-class data scheduler sched-cvlan1-qx

```

3. Create the third scheduler map.

```

[edit class-of-service scheduler-maps]
user@host# set tcp-map-cvlanx forwarding-class voice scheduler sched-cvlanx-qx
user@host# set tcp-map-cvlanx forwarding-class video scheduler sched-cvlanx-qx
user@host# set tcp-map-cvlanx forwarding-class data scheduler sched-cvlanx-qx

```

### Results

From configuration mode, confirm your configuration by entering the **show class-of-service scheduler-maps** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```

[edit]
user@host# show class-of-service scheduler-maps
tcp-map-cvlan0 {
  forwarding-class voice scheduler sched-cvlan0-qx;
  forwarding-class video scheduler sched-cvlan0-qx;
  forwarding-class data scheduler sched-cvlan0-qx;
}
tcp-map-cvlan1 {
  forwarding-class voice scheduler sched-cvlan1-q0;
  forwarding-class video scheduler sched-cvlan1-qx;
  forwarding-class data scheduler sched-cvlan1-qx;
}
tcp-map-cvlanx {
  forwarding-class voice scheduler sched-cvlanx-qx;
  forwarding-class video scheduler sched-cvlanx-qx;
  forwarding-class data scheduler sched-cvlanx-qx;
}

```

If you are done configuring the device, enter **commit** from configuration mode.

## Applying Traffic Control Profiles

**CLI Quick Configuration** To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service interfaces ge-1/0/0 output-traffic-control-profile
  tcp-500m-shaping-rate unit 0 output-control-traffic-control-profile tcp-cvlan0
set class-of-service interfaces ge-1/0/0 output-traffic-control-profile
  tcp-500m-shaping-rate unit 1 output-control-traffic-control-profile tcp-cvlan1
set class-of-service interfaces ge-1/0/0 output-traffic-control-profile
  tcp-500m-shaping-rate unit 2 output-control-traffic-control-profile tcp-cvlan2
set class-of-service interfaces ge-1/0/0 output-traffic-control-profile
  tcp-500m-shaping-rate unit 3 output-control-traffic-control-profile tcp-cvlan3
set class-of-service interfaces ge-1/0/0 output-traffic-control-profile
  tcp-500m-shaping-rate unit 4 output-control-traffic-control-profile tcp-cvlan4
set class-of-service interfaces ge-1/0/0 output-traffic-control-profile
  tcp-500m-shaping-rate interface-set-svlan0 output-control-traffic-control-profile
  tcp-svlan0
set class-of-service interfaces ge-1/0/0 output-traffic-control-profile
  tcp-500m-shaping-rate interface-set-svlan1 output-control-traffic-control-profile
  tcp-svlan1
```

**Step-by-Step Procedure** To apply traffic control profiles:

1. Set the interface.  

```
[edit class-of-service]
user@host# set interfaces ge-1/0/0
```
2. Set the traffic control profiles for the C-VLANs.  

```
[edit class-of-service interfaces ge-1/0/0 ]
user@host# set output-traffic-control-profile tcp-500m-shaping-rate unit 0
  output-control-traffic-control-profile tcp-cvlan0
user@host# set output-traffic-control-profile tcp-500m-shaping-rate unit 1
  output-control-traffic-control-profile tcp-cvlan1
user@host# set output-traffic-control-profile tcp-500m-shaping-rate unit 2
  output-control-traffic-control-profile tcp-cvlan2
user@host# set output-traffic-control-profile tcp-500m-shaping-rate unit 3
  output-control-traffic-control-profile tcp-cvlan3
user@host# set output-traffic-control-profile tcp-500m-shaping-rate unit 4
  output-control-traffic-control-profile tcp-cvlan4
```
3. Set the traffic control profiles for the S-VLANs.  

```
[edit class-of-service interfaces ge-1/0/0 ]
user@host# set output-traffic-control-profile tcp-500m-shaping-rate
  interface-set-svlan0 output-control-traffic-control-profile tcp-svlan0
user@host# set output-traffic-control-profile tcp-500m-shaping-rate
  interface-set-svlan1 output-control-traffic-control-profile tcp-svlan1
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service interfaces** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.



```
[edit]
user@host# show class-of-service interfaces
ge-1/0/0 {
  output-traffic-control-profile tcp-500m-shaping-rate;
  unit 0 {
    output-traffic-control-profile tcp-cvlan0;
  }
  unit 1 {
    output-traffic-control-profile tcp-cvlan1;
  }
  unit 2 {
    output-traffic-control-profile tcp-cvlan2;
  }
  unit 3 {
    output-traffic-control-profile tcp-cvlan3;
  }
  unit 4 {
    output-traffic-control-profile tcp-cvlan4;
  }
}
interface-set svlan0 {
  output-traffic-control-profile tcp-svlan0;
}
interface-set svlan1 {
  output-traffic-control-profile tcp-svlan1;
}
```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

### Verifying Scheduler Hierarchy Configuration

<b>Purpose</b>	Verify that the scheduler hierarchy is configured properly.
<b>Action</b>	<p>From operational mode, enter the following commands:</p> <ul style="list-style-type: none"> <li>• <b>show interface ge-1/0/0</b></li> <li>• <b>show class-of-service interfaces</b></li> <li>• <b>show class-of-service traffic-control-profiles</b></li> <li>• <b>show class-of-service schedulers</b></li> <li>• <b>show class-of-service drop-profiles</b></li> <li>• <b>show class-of-service scheduler-maps</b></li> </ul>
<b>Related Documentation</b>	<ul style="list-style-type: none"> <li>• <a href="#">Junos OS Feature Support Reference for SRX Series and J Series Devices</a></li> <li>• <a href="#">Understanding Hierarchical Schedulers on page 121</a></li> <li>• <a href="#">SRX1400, SRX3400, and SRX3600 Device Hardware Capabilities and Limitations on page 124</a></li> </ul>

- [Example: Controlling Remaining Traffic on page 138](#)
- [Understanding Internal Scheduler Nodes on page 143](#)

## Example: Controlling Remaining Traffic

---

This example shows how to control remaining traffic from the remaining logical interfaces.

- [Requirements on page 138](#)
- [Overview on page 138](#)
- [Configuration on page 140](#)
- [Verification on page 143](#)

### Requirements

Before you begin:

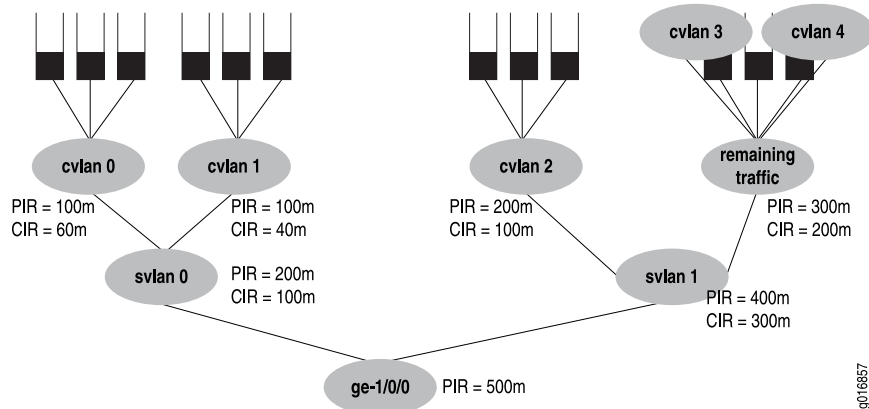
- Review how to configure schedulers. See [“Example: Configuring Class-of-Service Schedulers” on page 49](#).
- Review how to configure and apply scheduler maps. See [“Example: Configuring and Applying Scheduler Maps” on page 63](#).

### Overview

To configure transmit rate guarantees for the remaining traffic, you configure the **output-traffic-control-profile-remaining** statement specifying a guaranteed rate for the remaining traffic. Without this statement, the remaining traffic gets a default, minimal bandwidth. Similarly, you can specify the **shaping-rate** and **delay-buffer-rate** statements in the traffic control profile referenced with the **output-traffic-control-profile-remaining** statement to shape and provide buffering for remaining traffic.

In the interface shown in [Figure 5 on page 139](#), customer VLANs 3 and 4 have no explicit traffic control profile. However, the service provider might want to establish a shaping and guaranteed transmit rate for aggregate traffic heading for those C-VLANs. The solution is to configure and apply a traffic control profile for all remaining traffic on the interface.

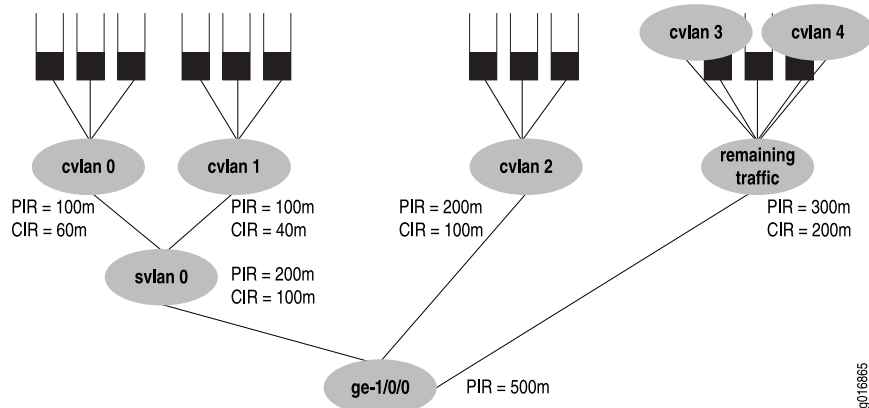
Figure 5: Example 1 Handling Remaining Traffic with no Explicit Traffic Control Profile



Example 1 considers the case where C-VLANs 3 and 4 have no explicit traffic control profile, yet need to establish a shaping and guaranteed transmit rate for traffic heading for those C-VLANs. The solution is to add a traffic control profile to the **svlan1** interface set. This example builds on the example used in [“Example: Configuring a Scheduler Hierarchy”](#) on page 126 and does not repeat all configuration details, only those at the S-VLAN level.

Next, consider Example 2 shown in [Figure 6 on page 139](#).

Figure 6: Example 2 Handling Remaining Traffic with an Interface Set



In Example 2, **ge-1/0/0** has five logical interfaces (C-VLAN 0, 1, 2, 3 and 4), and S-VLAN 0, which are covered by the interface set:

- Scheduling for the interface set **svlan0** is specified by referencing an **output-traffic-control-profile** statement, which specifies the **guaranteed-rate**, **shaping-rate**, and **delay-buffer-rate** statement values for the interface set. In this example, the output traffic control profile called **tcp-svlan0** guarantees 100 Mbps and shapes the interface set **svlan0** to 200 Mbps.
- Scheduling and queuing for remaining traffic of **svlan0** is specified by referencing an **output-traffic-control-profile-remaining** statement, which references a **scheduler-map**

statement that establishes queues for the remaining traffic. The specified traffic control profile can also configure guaranteed, shaping, and delay-buffer rates for the remaining traffic. In Example 2, **output-traffic-control-profile-remaining tcp-svlan0-rem** references **scheduler-map smap-svlan0-rem**, which calls for a best-effort queue for remaining traffic (that is, traffic on unit 3 and unit 4, which is not classified by the **svlan0** interface set). The example also specifies a **guaranteed-rate** of 200 Mbps and a **shaping-rate** of 300 Mbps for all remaining traffic.

- Scheduling and queuing for logical interface **ge-1/0/0 unit 1** is configured “traditionally” and uses an **output-traffic-control-profile** specified for that unit. In this example, **output-traffic-control-profile tcp-ift1** specifies scheduling and queuing for **ge-1/0/0 unit 1**.

## Configuration

This section contains the following topics:

- [Controlling Remaining Traffic With No Explicit Traffic Control Profile on page 140](#)
- [Controlling Remaining Traffic With An Interface Set on page 141](#)

### Controlling Remaining Traffic With No Explicit Traffic Control Profile

#### CLI Quick Configuration

To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service interfaces interface-set svlan0 output-traffic-control-profile
  tcp-svlan0
set class-of-service interfaces interface-set svlan1 output-traffic-control-profile tcp-svlan1
set class-of-service interfaces interface-set svlan1 output-traffic-control-profile-remaining
  tcp-svlan1-remaining
set class-of-service traffic-control-profiles tcp-svlan1 shaping-rate 400m guaranteed-rate
  300m
set class-of-service traffic-control-profiles tcp-svlan1-remaining shaping-rate 300m
  guaranteed-rate 200m scheduler-map smap-remainder
```

#### Step-by-Step Procedure

To control remaining traffic with no explicit traffic control profile:

1. Set the logical interfaces for the S-VLANs.  

```
[edit class-of-service interfaces]
user@host# set interface-set svlan0 output-traffic-control-profile tcp-svlan0
user@host# set interface-set svlan1 output-traffic-control-profile tcp-svlan1
user@host# set interface-set svlan1 output-traffic-control-profile-remaining
  tcp-svlan1-remaining
```
2. Set the shaping and guaranteed transmit rates for traffic heading for those C-VLANs.  

```
[edit class-of-service traffic-control-profiles]
user@host# set tcp-svlan1 shaping-rate 400m guaranteed-rate 300m
user@host# set tcp-svlan1-remaining shaping-rate 300m guaranteed-rate 200m
  scheduler-map smap-remainder
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service interfaces** and **show class-of-service traffic-control-profiles** commands. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service interfaces
interface-set svlan0 {
    output-traffic-control-profile tcp-svlan0;
}
interface-set svlan1 {
    output-traffic-control-profile tcp-svlan1;
    output-traffic-control-profile-remaining tcp-svlan1-remaining; # For all remaining traffic
}
```

```
[edit]
user@host# show class-of-service traffic-control-profiles
tcp-svlan1 {
    shaping-rate 400m;
    guaranteed-rate 300m;
}
tcp-svlan1-remaining {
    shaping-rate 300m;
    guaranteed-rate 200m;
    scheduler-map smap-remainder; # this smap is not shown in detail
}
```

If you are done configuring the device, enter **commit** from configuration mode.

### Controlling Remaining Traffic With An Interface Set

#### CLI Quick Configuration

To quickly configure this section of the example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service interfaces interface-set svlan0 output-traffic-control-profile
    tcp-svlan0
set class-of-service interfaces ge-1/0/0 output-traffic-control-profile-remaining
    tcp-svlan0-rem unit 1 output-traffic-control-profile tcp-ifl1
set class-of-service traffic-control-profiles tcp-svlan0 shaping-rate 200m guaranteed-rate
    100m
set class-of-service traffic-control-profiles tcp-svlan0-rem shaping-rate 300m
    guaranteed-rate 200m scheduler-map smap-svlan0-rem
set class-of-service traffic-control-profiles tcp-ifl1 scheduler-map smap-ifl1
set class-of-service scheduler-maps smap-svlan0-rem forwarding-class best-effort
    scheduler-sched-foo
set class-of-service scheduler-maps smap-ifl1 forwarding-class best-effort
    scheduler-sched-bar
set class-of-service scheduler-maps smap-ifl1 forwarding-class assured-forwarding
    scheduler-sched-bar
```

**Step-by-Step Procedure**

To control remaining traffic with an interface set:

1. Set the interface set for the S-VLAN.

```
[edit class-of-service interfaces]
user@host# set interface-set svlan0 output-traffic-control-profile tcp-svlan0
user@host# set ge-1/0/0 output-traffic-control-profile-remaining tcp-svlan0-rem
unit 1 output-traffic-control-profile tcp-ifl1
```

2. Set the traffic control profiles.

```
[edit class-of-service traffic-control-profiles]
user@host# set tcp-svlan0 shaping-rate 200m guaranteed-rate 100m
user@host# set tcp-svlan0-rem shaping-rate 300m guaranteed-rate 200m
scheduler-map smap-svlan0-rem
user@host# set tcp-ifl1 scheduler-map smap-ifl1
```

3. Set the scheduler map.

```
[edit class-of-service scheduler-maps]
user@host# set smap-svlan0-rem forwarding-class best-effort scheduler-sched-foo
user@host# set smap-ifl1 forwarding-class best-effort scheduler-sched-bar
user@host# set smap-ifl1 forwarding-class assured-forwarding scheduler-sched-bar
```

**Results**

From configuration mode, confirm your configuration by entering the **show class-of-service interfaces**, **show class-of-service traffic-control-profiles**, and **show class-of-service scheduler-maps** commands. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it. Example 2 does not include the **[edit interfaces]** configuration.

```
[edit]
user@host# show class-of-service interfaces
interface-set {
  svlan0 {
    output-traffic-control-profile tcp-svlan0; # Guarantee & shaper for svlan0
  }
}
ge-1/0/0 {
  output-traffic-control-profile-remaining tcp-svlan0-rem
  # Unit 3 and 4 are not explicitly configured, but captured by "remaining"
  unit 1 {
    output-traffic-control-profile tcp-ifl1; # Unit 1 be & ef queues
  }
}
```

```
[edit]
user@host# show class-of-service traffic-control-profiles
tcp-svlan0 {
  shaping-rate 200m;
  guaranteed-rate 100m;
}
tcp-svlan0-rem {
  shaping-rate 300m;
  guaranteed-rate 200m;
  scheduler-map smap-svlan0-rem; # This specifies queues for remaining traffic
}
```

```

tcp-ifl1 {
    scheduler-map smap-ifl1;
}

[edit]
user@host# show class-of-service scheduler-maps
smap-svlan0-rem {
    forwarding-class best-effort scheduler sched-foo;
}
smap-ifl1 {
    forwarding-class best-effort scheduler sched-bar;
    forwarding-class assured-forwarding scheduler sched-baz;
}

```

If you are done configuring the device, enter **commit** from configuration mode.

The configuration for the referenced schedulers is not given for this example.

## Verification

### Verifying Remaining Traffic Control

<b>Purpose</b>	Verify that the remaining traffic is controlled properly.
<b>Action</b>	<p>From operational mode, enter the following commands:</p> <ul style="list-style-type: none"> <li>• <b>show class-of-service interfaces</b></li> <li>• <b>show class-of-service traffic-control-profiles</b></li> <li>• <b>show class-of-service scheduler-maps</b></li> </ul>
<b>Related Documentation</b>	<ul style="list-style-type: none"> <li>• <a href="#">Junos OS Feature Support Reference for SRX Series and J Series Devices</a></li> <li>• <a href="#">Understanding Hierarchical Schedulers on page 121</a></li> <li>• <a href="#">SRX1400, SRX3400, and SRX3600 Device Hardware Capabilities and Limitations on page 124</a></li> </ul>

## Understanding Internal Scheduler Nodes

A node in the hierarchy is considered internal if either of the following conditions apply:

- One of its children nodes has a traffic control profile configured and applied.
- You configure the **internal-node** statement.

There are more resources available at the logical interface (unit) level than at the interface set level. It might be desirable to configure all resources at a single level, rather than spread over several levels. The **internal-node** statement provides this flexibility. This can be a helpful configuration device when interface-set queuing without logical interfaces is used exclusively on the interface.

You can use the **internal-node** statement to raise the interface set without children to the same level as the other configured interface sets with children, allowing them to compete for the same set of resources.

Using the **internal-node** statement allows statements to all be scheduled at the same level with or without children.

The following example makes the interface sets **if-set-1** and **if-set-2** internal:

```
[edit class-of-service interfaces ]
interface-set {
  if-set-1 {
    internal-node;
    output-traffic-control-profile tcp-200m-no-smap;
  }
  if-set-2 {
    internal-node;
    output-traffic-control-profile tcp-100m-no-smap;
  }
}
```

If an interface set has logical interfaces configured with a traffic control profile, then the use of the **internal-node** statement has no effect.

Internal nodes can specify a **traffic-control-profile-remaining** statement.

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Understanding Hierarchical Schedulers on page 121](#)
- [SRX1400, SRX3400, and SRX3600 Device Hardware Capabilities and Limitations on page 124](#)
- [Example: Configuring a Scheduler Hierarchy on page 126](#)
- [Example: Controlling Remaining Traffic on page 138](#)



## PART 4

# Class of Service Virtual Channels and Tunnels Configuration

- [Virtual Channels on page 147](#)
- [CoS Queuing for Tunnels on page 155](#)



## CHAPTER 12

# Virtual Channels

- [Virtual Channels Overview on page 147](#)
- [Understanding Virtual Channels on page 148](#)
- [Example: Configuring Virtual Channels on page 149](#)

## Virtual Channels Overview

---

You can configure virtual channels to limit traffic sent from a corporate headquarters to branch its offices. Virtual channels might be required when the headquarters site has an expected aggregate bandwidth higher than that of the individual branch offices. The headquarters router must limit the traffic sent to each branch office router to avoid oversubscribing their links. For instance, if branch 1 has a 1.5 Mbps link and the headquarters router attempts to send 6 Mbps to branch 1, all of the traffic in excess of 1.5 Mbps is dropped in the ISP network.

You configure virtual channels on a logical interface. Each virtual channel has a set of eight queues with a scheduler and an optional shaper. You can use an output firewall filter to direct traffic to a particular virtual channel. For example, a filter can direct all traffic with a destination address for branch office 1 to virtual channel 1, and all traffic with a destination address for branch office 2 to virtual channel 2.

Although a virtual channel group is assigned to a logical interface, a virtual channel is not the same as a logical interface. The only features supported on a virtual channel are queuing, packet scheduling, and accounting. Rewrite rules and routing protocols apply to the entire logical interface.

When you configure virtual channels on an interface, the virtual channel group uses the same scheduler and shaper you configure at the [edit interfaces *interface-name* unit *logical-unit-number*] hierarchy level. In this way, virtual channels are an extension of regular scheduling and shaping and not an independent entity.

### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Understanding Virtual Channels on page 148](#)
- [Example: Configuring Virtual Channels on page 149](#)

## Understanding Virtual Channels

---

You configure a virtual channel to set up queuing, packet scheduling, and accounting rules to be applied to one or more logical interfaces. You then must apply the virtual channel to a particular logical interface.

You also create a list of virtual channels that you can assign to a virtual channel group. To define a virtual channel group that you can assign to a logical interface, include the **virtual-channel-groups** statement at the [edit class-of-service] hierarchy level.

The *virtual-channel-group-name* can be any name that you want. The *virtual-channel-name* must be one of the names that you define at the [edit class-of-service virtual-channels] hierarchy level. You can include multiple virtual channel names in a group.

The scheduler map is required. The *map-name* must be one of the scheduler maps that you configure at the [edit class-of-service scheduler-maps] hierarchy level. For more information, see [“Example: Configuring Class-of-Service Schedulers” on page 49](#).

The shaping rate is optional. If you configure the shaping rate as a percentage, when the virtual channel is applied to a logical interface, the shaping rate is set to the specified percentage of the interface bandwidth. If you configure a shaper on a virtual channel, the shaper limits the maximum bandwidth transmitted by that virtual channel. Virtual channels without a shaper can use the full logical interface bandwidth. If there are multiple unshaped virtual channels, they share the available logical interface bandwidth equally.

When you apply the virtual channel group to a logical interface, a set of eight queues is created for each of the virtual channels in the group. The **scheduler-map** statement applies a scheduler to these queues. If you include the **shaping-rate** statement, a shaper is applied to the entire virtual channel.

You must configure one of the virtual channels in the group to be the default channel. Therefore, the **default** statement is required in the configuration of one virtual channel per channel group. Any traffic not explicitly directed to a particular channel is transmitted by this default virtual channel.

For the corresponding physical interface, you must also include the **per-unit-scheduler** statement at the [edit interfaces *interface-name*] hierarchy level as follows:

```
[edit interfaces interface-name]  
per-unit-scheduler;
```

The **per-unit-scheduler** statement enables one set of output queues for each logical interface configured under the physical interface.

When you apply a virtual channel group to a logical interface, the software creates a set of eight queues for each of the virtual channels in the group.

If you apply a virtual channel group to multiple logical interfaces, the software creates a set of eight queues on each logical interface. The virtual channel names listed in the group are used on all the logical interfaces. We recommend specifying the scheduler and shaping rates in the virtual channel configuration in terms of percentages, rather than

absolute rates. This allows you to apply the same virtual channel group to logical interfaces that have different bandwidths.

When you apply a virtual channel group to a logical interface, you cannot include the **scheduler-map** and **shaping-rate** statements at the [edit class-of-service interfaces *interface-name* unit *logical-unit-number*] hierarchy level. In other words, you can configure a scheduler map and a shaping rate on a logical interface, or you can configure virtual channels on the logical interface, but not both.

If you configure multiple logical interfaces on a single physical interface, each logical interface is guaranteed an equal fraction of the physical interface bandwidth as follows:

$$\text{logical-interface-bandwidth} = \frac{\text{physical-interface-bandwidth}}{\text{number-of-logical-interfaces}}$$

If one or more logical interfaces do not completely use their allocation, the other logical interfaces share the excess bandwidth equally.

If you configure multiple virtual channels on a logical interface, they are each guaranteed an equal fraction of the logical interface bandwidth as follows:

$$\text{virtual-channel-bandwidth} = \frac{\text{logical-interface-bandwidth}}{\text{number-of-virtual-channels}}$$

If you configure a shaper on a virtual channel, the shaper limits the maximum bandwidth transmitted by that virtual channel. Virtual channels without a shaper can use the full logical interface bandwidth. If there are multiple unshaped virtual channels, they share the available logical interface bandwidth equally.

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Virtual Channels Overview on page 147](#)
- [Example: Configuring Virtual Channels on page 149](#)

## Example: Configuring Virtual Channels

This example shows how to create virtual channels between a headquarters and its branch office.

- [Requirements on page 149](#)
- [Overview on page 150](#)
- [Configuration on page 150](#)
- [Verification on page 153](#)

### Requirements

Before you begin, ensure that your headquarters and branch office have a network connection where the expected aggregate bandwidth is higher for your headquarters than for your branch office. The devices at your headquarters will then be set up to limit the traffic sent to the branch office to avoid oversubscribing the link.

## Overview

In this example, you create the virtual channels as branch1-vc, branch2-vc, branch3-vc, and default-vc. You then define the virtual channel group as wan-vc-group to include the four virtual channels and assign the scheduler map as bestscheduler to each virtual channel. Three of the virtual channels are shaped to 1.5 Mbps. The fourth virtual channel is default-vc, and it is not shaped so it can use the full interface bandwidth.

Then you apply them in the firewall filter as choose-vc to the Services Router's interface t3-1/0/0. The output filter on the interface sends all traffic with a destination address matching 192.168.10.0/24 to branch1-vc, and similar configurations are set for branch2-vc and branch3-vc. Traffic not matching any of the addresses goes to the default, unshaped virtual channel.

## Configuration

### CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service virtual-channels branch1-vc
set class-of-service virtual-channels branch2-vc
set class-of-service virtual-channels branch3-vc
set class-of-service virtual-channels default-vc
set class-of-service virtual-channel-groups wan-vc-group branch1-vc scheduler-map
  bestscheduler
set class-of-service virtual-channel-groups wan-vc-group branch2-vc scheduler-map
  bestscheduler
set class-of-service virtual-channel-groups wan-vc-group branch3-vc scheduler-map
  bestscheduler
set class-of-service virtual-channel-groups wan-vc-group default-vc scheduler-map
  bestscheduler
set class-of-service virtual-channel-groups wan-vc-group default-vc default
set class-of-service virtual-channel-groups wan-vc-group branch1-vc shaping-rate
  1500000
set class-of-service virtual-channel-groups wan-vc-group branch2-vc shaping-rate
  1500000
set class-of-service virtual-channel-groups wan-vc-group branch3-vc shaping-rate
  1500000
set class-of-service interfaces t3-1/0/0 unit 0 virtual-channel-group wan-vc-group
set firewall family inet filter choose-vc term branch1 from destination-address
  192.168.10.0/24
set firewall family inet filter choose-vc term branch1 then accept
set firewall family inet filter choose-vc term branch1 then virtual-channel branch1-vc
set firewall family inet filter choose-vc term branch1 then virtual-channel branch2-vc
set firewall family inet filter choose-vc term branch1 then virtual-channel branch3-vc
set interfaces t3-1/0/0 unit 0 family inet filter output choose-vc
```

**Step-by-Step Procedure** The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the *Junos OS CLI User Guide*.

To configure virtual channels:

1. Define the virtual channels and the default virtual channel.

```
[edit]
user@host# edit class-of-service
user@host# set virtual-channels branch1-vc
user@host# set virtual-channels branch2-vc
user@host# set virtual-channels branch3-vc
user@host# set virtual-channels default-vc
```

2. Define the virtual channel group and assign each virtual channel a scheduler map.

```
[edit class-of-service]
user@host# set virtual-channel-groups wan-vc-group branch1-vc scheduler-map
bestscheduler
user@host# set virtual-channel-groups wan-vc-group branch2-vc scheduler-map
bestscheduler
user@host# set virtual-channel-groups wan-vc-group branch3-vc scheduler-map
bestscheduler
user@host# set virtual-channel-groups wan-vc-group default-vc scheduler-map
bestscheduler
user@host# set virtual-channel-groups wan-vc-group default-vc default
```

3. Specify a shaping rate.

```
[edit class-of-service]
user@host# set virtual-channel-groups wan-vc-group branch1-vc shaping-rate 1.5m
user@host# set virtual-channel-groups wan-vc-group branch2-vc shaping-rate
1.5m
user@host# set virtual-channel-groups wan-vc-group branch3-vc shaping-rate
1.5m
```

4. Apply the virtual channel group to the logical interface.

```
[edit class-of-service]
user@host# set interfaces t3-1/0/0 unit 0 virtual-channel-group wan-vc-group
```

5. Create the firewall filter to select the traffic.

```
[edit firewall]
user@host# set family inet filter choose-vc term branch1 from destination
192.168.10.0/24
user@host# set family inet filter choose-vc term branch1 then accept
user@host# set family inet filter choose-vc term branch1 then virtual-channel
branch1-vc
user@host# set family inet filter choose-vc term branch1 then virtual-channel
branch2-vc
user@host# set family inet filter choose-vc term branch1 then virtual-channel
branch3-vc
```

6. Apply the firewall filter to output traffic.

```
[edit interfaces]
user@host# set t3-1/0/0 unit 0 family inet filter output choose-vc
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service**, **show firewall**, and **show interfaces t3-1/0/0** commands. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
user@host# show class-of-service
virtual-channels {
  branch1-vc;
  branch2-vc;
  branch3-vc;
  default-vc;
}
virtual-channel-groups {
  wan-vc-group {
    branch1-vc {
      scheduler-map bestscheduler;
      shaping-rate 1500000;
    }
    branch2-vc {
      scheduler-map bestscheduler;
      shaping-rate 1500000;
    }
    branch3-vc {
      scheduler-map bestscheduler;
      shaping-rate 1500000;
    }
    default-vc {
      scheduler-map bestscheduler;
      default;
    }
  }
}
interfaces {
  t3-1/0/0 {
    unit 0 {
      virtual-channel-group wan-vc-group;
    }
  }
}
[edit]
user@host# show firewall
family inet {
  filter choose-vc {
    term branch1 {
      from {
        destination-address {
          192.168.10.0/24;
        }
      }
      then {
        virtual-channel branch3-vc;
        accept;
      }
    }
  }
}
```



```
}
[edit]
user@host# show interfaces t3-1/0/0
unit 0 {
  family inet {
    filter {
      output choose-vc;
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

Confirm that the configuration is working properly.

- [Verifying Virtual Channel Configuration on page 153](#)

---

### Verifying Virtual Channel Configuration

**Purpose** Verify that the virtual channels are properly configured.

**Action** From configuration mode, enter the **show class-of-service**, **show firewall**, and **show interfaces t3-1/0/0** commands.

**Related Documentation**

- [Junos OS Interfaces Configuration Guide for Security Devices](#)
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Junos OS System Basics and Services Command Reference](#)
- [Virtual Channels Overview on page 147](#)
- [Understanding Virtual Channels on page 148](#)



## CHAPTER 13

# CoS Queuing for Tunnels

- [CoS Queuing for Tunnels Overview on page 155](#)
- [Understanding the ToS Value of a Tunnel Packet on page 158](#)
- [Example: Configuring CoS Queuing for GRE or IP-IP Tunnels on page 158](#)

### CoS Queuing for Tunnels Overview

---

On an SRX Series device or J Series device running Junos OS, a tunnel interface is an internal interface and supports many of the same CoS features as a physical interface. The tunnel interface creates a virtual point-to-point link between two SRX Series devices or two J Series devices at remote points over an IP network.

For example, you can configure CoS features for generic routing encapsulation (GRE) and IP-IP tunnel interfaces. Tunneling protocols encapsulate packets inside a transport protocol.

GRE and IP-IP tunnels are used with services like IPsec and NAT to set up point-to-point VPNs. Junos OS allows you to enable CoS queuing, scheduling, and shaping for traffic exiting through these tunnel interfaces. For an example of configuring CoS Queuing for GRE tunnels, see [“Example: Configuring CoS Queuing for GRE or IP-IP Tunnels” on page 158](#). For information about configuring tunnel services, see [Junos OS Services Interfaces Configuration Guide](#).

This topic includes the following sections:

- [Benefits of CoS Queuing for Tunnel Interfaces on page 156](#)
- [How CoS Queuing Works on page 156](#)
- [Limitations on CoS Shapers for Tunnel Interfaces on page 157](#)

## Benefits of CoS Queuing for Tunnel Interfaces

CoS queuing enabled for tunnel interfaces has the following benefits:

- Segregates tunnel traffic.

Each tunnel can be shaped so that a tunnel with low-priority traffic cannot flood other tunnels that carry high-priority traffic.

Traffic for one tunnel does not impact traffic on other tunnels.

- Controls tunnel bandwidth.

Traffic through various tunnels is limited to not exceed a certain bandwidth.

For example, suppose you have three tunnels to three remote sites through a single WAN interface. You can select CoS parameters for each tunnel such that traffic to some sites gets more bandwidth than traffic to other sites.

- Customizes CoS policies.

You can apply different queuing, scheduling, and shaping policies to different tunnels based on user requirements. Each tunnel can be configured with different scheduler maps, different queue depths, and so on. Customization allows you to configure granular CoS policy providing for better control over tunnel traffic.

- Prioritizes traffic before it enters a tunnel.

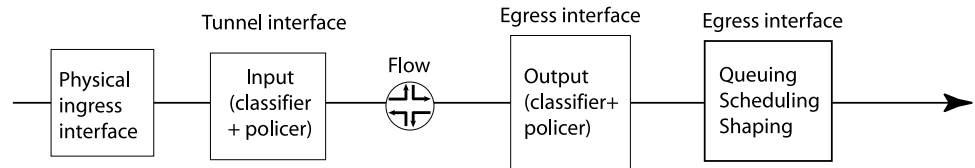
For example, CoS queuing avoids having low-priority packets scheduled ahead of high-priority packets when the interface speed is higher than the tunnel traffic speed. This feature is most useful when combined with IPsec. Typically, IPsec processes packets in a FIFO manner. However, with CoS queuing each tunnel can prioritize high-priority packets over low-priority packets. Also, each tunnel can be shaped so that a tunnel with low-priority traffic does not flood tunnels carrying high-priority traffic.

## How CoS Queuing Works

[Figure 7 on page 157](#) shows CoS-related processing that occurs for traffic entering and exiting a tunnel. For information on flow-based packet processing, see the [Junos OS Security Configuration Guide](#).

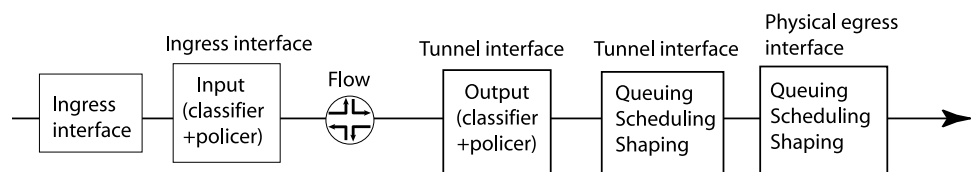
**Figure 7: CoS Processing for Tunnel Traffic**

Inbound traffic traversing through the tunnel:



g020124

Outbound traffic traversing through the tunnel:



### Limitations on CoS Shapers for Tunnel Interfaces

When defining a CoS shaping rate on a tunnel interface, be aware of the following restrictions:

- The shaping rate on the tunnel interface must be less than that of the physical egress interface.
- The shaping rate only measures the packet size that includes the Layer 3 packet with GRE or IP-IP encapsulation. The Layer 2 encapsulation added by the physical interface is not factored into the shaping rate measurement.
- The CoS behavior works as expected only when the physical interface carries the shaped GRE or IP-IP tunnel traffic alone. If the physical interface carries other traffic, thereby lowering the available bandwidth for tunnel interface traffic, the CoS features do not work as expected.
- You cannot configure a logical interface shaper and a virtual circuit shaper simultaneously on the router. If virtual circuit shaping is desired, do not define a logical interface shaper. Instead, define a shaping rate for all the virtual circuits.

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Junos OS Security Configuration Guide](#)
- [Understanding the ToS Value of a Tunnel Packet on page 158](#)
- [Example: Configuring CoS Queuing for GRE or IP-IP Tunnels on page 158](#)

## Understanding the ToS Value of a Tunnel Packet

---

To ensure that the tunneled packet continues to have the same CoS treatment even in the physical interface, you must preserve the type-of-service (ToS) value from the inner IP header to the outer IP header.

For transit traffic, Junos OS preserves the CoS value of the tunnel packet for both GRE and IP-IP tunnel interfaces. The inner IPv4 or IPv6 ToS bits are copied to the outer IPv4 ToS header for both types of tunnel interfaces.

For Routing Engine traffic, however, the router handles GRE tunnel interface traffic differently from IP-IP tunnel interface traffic. Unlike for IP-IP tunnels, the IPv4 ToS bits are not copied to the outer IPv4 header by default. You have a configuration option to copy the ToS value from the packet's inner IPv4 header to the outer IPv4 header.

To copy the inner ToS bits to the outer IP header (which is required for some tunneled routing protocols) on packets sent by the Routing Engine, include the **copy-tos-to-outer-ip-header** statement at the logical unit hierarchy level of a GRE interface.



**NOTE:** For IPv6 traffic, the inner ToS value is not copied to the outer IPv4 header for both GRE and IP-IP tunnel interfaces even if the **copy-tos-to-outer-ip-header** statement is specified.

This example copies the inner ToS bits to the outer IP header on a GRE tunnel:

```
[edit interfaces]
gr-0/0/0 {
  unit 0 {
    copy-tos-to-outer-ip-header;
    family inet;
  }
}
```

### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [CoS Queuing for Tunnels Overview on page 155](#)
- [Example: Configuring CoS Queuing for GRE or IP-IP Tunnels on page 158](#)

## Example: Configuring CoS Queuing for GRE or IP-IP Tunnels

---

This example shows how to configure CoS queuing for GRE or IP-IP tunnels.

- [Requirements on page 159](#)
- [Overview on page 159](#)
- [Configuration on page 159](#)
- [Verification on page 161](#)

## Requirements

Before you begin:

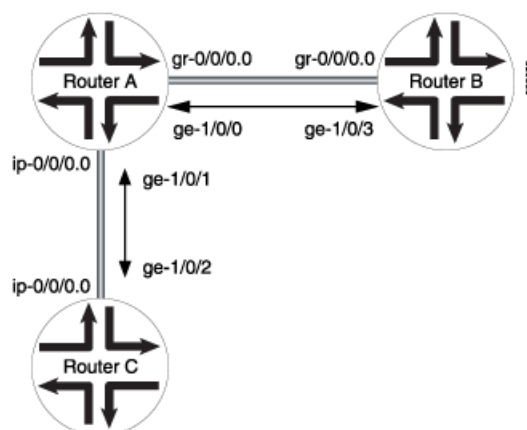
- Establish a main office and a branch office connected by a VPN using GRE or IP-IP tunneled interfaces.
- Configure forwarding classes and schedulers. See [“Example: Assigning Forwarding Classes to Output Queues”](#) on page 31 and [“Example: Configuring Class-of-Service Schedulers”](#) on page 49.
- Configure a scheduler map and apply the scheduler map to the tunnel interface. See [“Example: Configuring and Applying Scheduler Maps”](#) on page 63.
- Configure classifiers and apply them to the tunnel interface. See [“Example: Configuring Behavior Aggregate Classifiers”](#) on page 19.
- Create rewrite rules and apply them to the tunnel interface. See [“Example: Configuring and Applying Rewrite Rules”](#) on page 73.

## Overview

In this example, you enable tunnel queuing, define the GRE tunnel interface as `gr-0/0/0`, (Alternatively, you could define the IP-IP tunnel interface as `ip-0/0/0`.) and set the per unit scheduler. You then set the GRE tunnel's line rate as 100 Mbps by using the shaper definition.

In [Figure 8 on page 159](#), Router A has a GRE tunnel established with Router B through interface `ge-1/0/0`. Router A also has an IP-IP tunnel established with Router C through interface `ge-1/0/1`. Router A is configured so that tunnel-queuing is enabled. Router B and Router C do not have tunnel-queuing configured.

**Figure 8: Configuring CoS Queuing for GRE Tunnels**



## Configuration

**CLI Quick Configuration** To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network

configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set chassis fpc 0 pic 0 tunnel-queuing
set interfaces gr-0/0/0 unit 0
set interfaces gr-0/0/0 per-unit-scheduler
set class-of-services interfaces gr-0/0/0 unit 0 shaping-rate 100m
```

#### Step-by-Step Procedure

To configure CoS queuing for GRE tunnels:

1. Enable tunnel queuing on the device.

```
[edit]
user@host# set chassis fpc 0 pic 0 tunnel-queuing
```

2. Define the GRE tunnel interface.

```
[edit]
user@host# set interfaces gr-0/0/0 unit 0
```

3. Define the per-unit scheduler for the GRE tunnel interface.

```
[edit]
user@host# set interfaces gr-0/0/0 per-unit-scheduler
```

4. Define the GRE tunnel's line rate by using the shaper definition.

```
[edit]
user@host# set class-of-services interfaces gr-0/0/0 unit 0 shaping-rate 100m
```

#### Results

From configuration mode, confirm your configuration by entering the **show class-of-service interfaces gr-0/0/0**, **show interfaces gr-0/0/0**, and **show chassis** commands. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service interfaces gr-0/0/0
unit 0 {
  shaping-rate 100m;
}
[edit]
user@host# show interfaces gr-0/0/0
per-unit-scheduler;
unit 0;
[edit]
user@host# show chassis
fpc 0 {
  pic 0 {
    tunnel-queuing;
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.



## Verification

Confirm that the configuration is working properly.

- [Verifying a CoS Queuing for GRE Tunnel Configuration on page 161](#)
- [Verifying a CoS Queuing for IP-IP Tunnel Configuration on page 162](#)

### Verifying a CoS Queuing for GRE Tunnel Configuration

**Purpose** Verify that the device is configured properly for tunnel configuration.

**Action** From configuration mode, enter the **show interfaces queue gr-0/0/0.0** command.



**NOTE:** If you enter **gr-0/0/0.0** only, queue information for all tunnels is displayed. If you enter **gr-0/0/0.0**, queue information for the specific tunnel is displayed.

```

user@host> show interfaces queue gr-0/0/0.0
Logical interface gr-0/0/0.0 (Index 68) (SNMP ifIndex 112)
Forwarding classes: 8 supported, 4 in use
Egress queues: 8 supported, 4 in use Burst size: 0
Queue: 0, Forwarding classes: VOICE
  Queued:
    Packets      :          7117734          7998 pps
    Bytes        :          512476848        4606848 bps
  Transmitted:
    Packets      :          4548146           3459 pps
    Bytes        :          327466512        1992912 bps
    Tail-dropped packets :           0           0 pps
    RED-dropped packets :          2569421         4537 pps
      Low        :           0           0 pps
      Medium-low :           0           0 pps
      Medium-high :           0           0 pps
      High       :          2569421         4537 pps
    RED-dropped bytes :          184998312        2613640 bps
      Low        :           0           0 bps
      Medium-low :           0           0 bps
      Medium-high :           0           0 bps
      High       :          184998312        2613640 bps
Queue: 1, Forwarding classes: GOLD
  Queued:
    Packets      :          117600           0 pps
    Bytes        :          8467200           0 bps
  Transmitted:
    Packets      :          102435           0 pps
    Bytes        :          7375320           0 bps
    Tail-dropped packets :           0           0 pps
    RED-dropped packets :          15165           0 pps
      Low        :           0           0 pps
      Medium-low :           0           0 pps
      Medium-high :           0           0 pps
      High       :          15165           0 pps
    RED-dropped bytes :          1091880           0 bps
      Low        :           0           0 bps

```

```

      Medium-low      :           0          0 bps
      Medium-high     :           0          0 bps
      High            :      1091880        0 bps
Queue: 2, Forwarding classes: SILVER
  Queued:
    Packets          :           0          0 pps
    Bytes            :           0          0 bps
  Transmitted:
    Packets          :           0          0 pps
    Bytes            :           0          0 bps
    Tail-dropped packets :           0          0 pps
    RED-dropped packets :           0          0 pps
      Low            :           0          0 pps
      Medium-low     :           0          0 pps
      Medium-high    :           0          0 pps
      High           :           0          0 pps
    RED-dropped bytes :           0          0 bps
      Low            :           0          0 bps
      Medium-low     :           0          0 bps
      Medium-high    :           0          0 bps
      High           :           0          0 bps
Queue: 3, Forwarding classes: BRONZE
  Queued:
    Packets          :           0          0 pps
    Bytes            :           0          0 bps
  Transmitted:
    Packets          :           0          0 pps
    Bytes            :           0          0 bps
    Tail-dropped packets :           0          0 pps
    RED-dropped packets :           0          0 pps
      Low            :           0          0 pps
      Medium-low     :           0          0 pps
      Medium-high    :           0          0 pps
      High           :           0          0 pps
    RED-dropped bytes :           0          0 bps
      Low            :           0          0 bps
      Medium-low     :           0          0 bps
      Medium-high    :           0          0 bps
      High           :           0          0 bps

```

### Verifying a CoS Queuing for IP-IP Tunnel Configuration

**Purpose** Verify that the device is configured properly for tunnel configuration.

**Action** From configuration mode, enter the **show interfaces queue ip-0/0/0.0** command.



**NOTE:** If you enter **ip-0/0/0.0** only, queue information for all tunnels is displayed. If you enter **ip-0/0/0.0**, queue information for the specific tunnel is displayed.

- Related Documentation**
- [Junos OS Interfaces Configuration Guide for Security Devices](#)
  - [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
  - [CoS Queuing for Tunnels Overview on page 155](#)

- [Understanding the ToS Value of a Tunnel Packet on page 158](#)



## PART 5

# Class of Service with IPv6 and I/O Cards

- [CoS Functions for IPv6 Traffic on page 167](#)
- [CoS and I/O Cards on page 179](#)



# CoS Functions for IPv6 Traffic

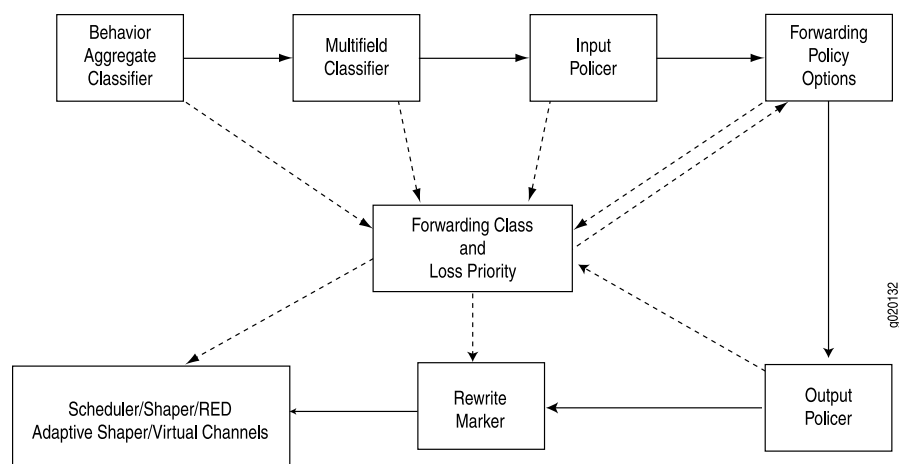
- [CoS Functions for IPv6 Traffic Overview on page 167](#)
- [Understanding CoS with DSCP IPv6 BA Classifier on page 169](#)
- [Example: Configuring CoS with DSCP IPv6 BA Classifiers on page 171](#)
- [Understanding DSCP IPv6 Rewrite Rules on page 174](#)
- [Example: Configuring CoS with DSCP IPv6 Rewrite Rules on page 175](#)

## CoS Functions for IPv6 Traffic Overview

Class-of-service (CoS) processing for IPv6 traffic uses the IPv6 DiffServ code point (DSCP) value. The IPv6 DSCP value is the first six bits in the 8-bit Traffic Class field of the IPv6 header. The DSCP value is used to determine the behavior aggregate (BA) classification for the packet entering the network device. You use classifier rules to map the DSCP code points to a forwarding class and packet loss priority. You use rewrite rules to map the forwarding class and packet loss priority back to DSCP values on packets exiting the device.

[Figure 9 on page 167](#) shows the components of the CoS features for Juniper Networks devices, illustrating the sequence in which they interact.

**Figure 9: Packet Flow Through an SRX Series or a J Series Device**





**NOTE:** Not all CoS features are supported on all devices.

- CoS components perform the following operations:

BA classifier rules map DSCP code points to a forwarding class and loss priority. The forwarding class and loss priority determine the per-hop behavior of the packet throughout the system. The forwarding class associates a packet with an outbound transmission queue. Loss priority affects the scheduling of a packet without affecting the relative ordering of packets. BA classification is a simple way that “downstream” nodes can honor the CoS objectives that were encoded “upstream.”

See [“Example: Configuring CoS with DSCP IPv6 BA Classifiers” on page 171.](#)

- Multifield classifier rules overwrite the initial forwarding class and loss priority determination read by the BA classifier rule. You typically use multifield classifier rules on nodes close to the content origin, where a packet might not have been encoded with the desired DSCP values in the headers. A multifield classifier rule assigns packets to a forwarding class and assigns a packet loss priority based on filters, such as source IP, destination IP, port, or application.

See [“Example: Configuring and Applying a Firewall Filter for a Multifield Classifier” on page 89.](#)

- Input policers meter traffic to see if traffic flow exceeds its service level. Policers might discard, change the forwarding class and loss priority, or set the packet loss priority bit of a packet. A packet for which the packet loss priority bit is set has an increased probability of being dropped during congestion.
- Scheduler maps are applied to interfaces and associate the outgoing packets with a scheduler and a forwarding class.

The scheduler manages the output transmission queue, including:

- Buffer size—Defines the period for which a packet is stored during congestion.
- Scheduling priority and transmit rate—Determines the order in which a packet is transmitted.
- Drop profile—Defines how aggressively to drop a packet that is using a particular scheduler.

See [“Example: Configuring Class-of-Service Schedulers” on page 49.](#)

- Output policers meter traffic and might change the forwarding class and loss priority of a packet if a traffic flow exceeds its service level.
- Rewrite rules map forwarding class and packet loss priority to DSCP values. You typically use rewrite rules in conjunction with multifield classifier rules close to the content origin, or when the device is at the border of a network and must alter the code points to meet the policies of the targeted peer.

See [“Example: Configuring CoS with DSCP IPv6 Rewrite Rules” on page 175.](#)



Only BA classification rules and rewrite rules require special consideration to support CoS for IPv6 traffic. The program logic for the other CoS features is not sensitive to differences between IPv4 and IPv6 traffic.

**Related Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Understanding CoS with DSCP IPv6 BA Classifier on page 169](#)
- [Example: Configuring CoS with DSCP IPv6 BA Classifiers on page 171](#)
- [Understanding DSCP IPv6 Rewrite Rules on page 174](#)
- [Example: Configuring CoS with DSCP IPv6 Rewrite Rules on page 175](#)

## Understanding CoS with DSCP IPv6 BA Classifier

A behavior aggregate (BA) classifier rule maps DSCP code points to a forwarding class and loss priority. The forwarding class and loss priority determine the per-hop behavior of the packet throughout the system. The forwarding class associates a packet with an outbound transmission queue. Loss priority affects the scheduling of a packet without affecting the relative ordering of packets.

BA classification can be applied within one DiffServ domain or between two domains, where each domain honors the CoS results generated by the other domain. [Table 35 on page 169](#) shows the mapping for the default DSCP IPv6 BA classifier.

**Table 35: Default IPv6 BA Classifier Mapping**

Code Points	DSCP IPv6 Alias	Forwarding Class	Packet Loss Priority
101110	ef	expedited-forwarding	low
001010	af11	assured-forwarding	low
001100	af12	assured-forwarding	high
001110	af13	assured-forwarding	high
010010	af21	best-effort	low
010100	af22	best-effort	low
010110	af23	best-effort	low
011010	af31	best-effort	low
011100	af32	best-effort	low
011110	af33	best-effort	low
100010	af41	best-effort	low

Table 35: Default IPv6 BA Classifier Mapping (*continued*)

Code Points	DSCP IPv6 Alias	Forwarding Class	Packet Loss Priority
100100	af42	best-effort	low
100110	af43	best-effort	low
000000	be	best-effort	low
001000	cs1	best-effort	low
010000	cs2	best-effort	low
011000	cs3	best-effort	low
100000	cs4	best-effort	low
101000	cs5	best-effort	low
110000	nc1/cs6	network-control	low
111000	nc2/cs7	network-control	low

You can use the CLI **show** command to display the settings for the CoS classifiers. The following command shows the settings for the default DSCP IPv6 classifier:

```

user@host# show class-of-service classifier type dscp-ipv6
Classifier: dscp-ipv6-default, Code point type: dscp-ipv6, Index: 8
  Code point      Forwarding class      Loss priority
  000000          best-effort           low
  000001          best-effort           low
  000010          best-effort           low
  000011          best-effort           low
  000100          best-effort           low
  000101          best-effort           low
  011011          best-effort           low
  ...
Classifier: dscp-ipv6-compatibility, Code point type: dscp-ipv6, Index: 9
  Code point      Forwarding class      Loss priority
  000000          best-effort           low
  000001          best-effort           low
  000010          best-effort           low
  000011          best-effort           low
  000100          best-effort           low
  000101          best-effort           low
  000110          best-effort           low
  000111          best-effort           low
  ...

```



**NOTE:** The predefined classifier named `dscp-ipv6-compatibility` maps all code point loss priorities to low. It maps 110000 and 111000 (typically seen in network control packets) to the network-control class and all other code points to the best-effort class. The `dscp-ipv6-compatibility` classifier is an implicit classifier similar to `ipprec-compatibility`, which is provided to map IP precedence bits in IPv4 traffic when no classifier has been configured.

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Example: Configuring CoS with DSCP IPv6 BA Classifiers on page 171](#)
- [CoS Functions for IPv6 Traffic Overview on page 167](#)
- [Understanding DSCP IPv6 Rewrite Rules on page 174](#)
- [Example: Configuring CoS with DSCP IPv6 Rewrite Rules on page 175](#)

## Example: Configuring CoS with DSCP IPv6 BA Classifiers

This example shows how to associate an interface with a default or user-defined DSCP IPv6 BA classifier.

- [Requirements on page 171](#)
- [Overview on page 171](#)
- [Configuration on page 171](#)
- [Verification on page 173](#)

### Requirements

Before you begin, configure the `ge-0/0/0` interface on the device for IPv6 and define your user-defined DSCP IPv6 classifier settings. See [“Understanding CoS with DSCP IPv6 BA Classifier” on page 169](#).

### Overview

In this example, you configure CoS and define forwarding classes. You create the behavior aggregate classifier for DiffServ CoS as `dscp-ipv6-example` and import the default DSCP IPv6 classifier.

You then specify the best-effort forwarding class as `be-class`, the expedited forwarding class as `ef-class`, the assured forwarding class as `af-class`, and the network control forwarding class as `nc-class`. Finally, you apply your user-defined classifier to interface `ge-0/0/0`.

### Configuration

#### CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service forwarding-classes queue 0 be-class
set class-of-service forwarding-classes queue 1 ef-class
set class-of-service forwarding-classes queue 2 af-class
set class-of-service forwarding-classes queue 3 nc-class
set class-of-service classifiers dscp-ipv6 dscp-ipv6-example import default
set class-of-service classifiers dscp-ipv6 dscp-ipv6-example forwarding-class be-class
  loss-priority high code-points 000001
set class-of-service classifiers dscp-ipv6 dscp-ipv6-example forwarding-class ef-class
  loss-priority high code-points 101111
set class-of-service classifiers dscp-ipv6 dscp-ipv6-example forwarding-class af-class
  loss-priority high code-points 001100
set class-of-service classifiers dscp-ipv6 dscp-ipv6-example forwarding-class nc-class
  loss-priority high code-points 110001
set class-of-service interfaces ge-0/0/0 unit 0 classifiers dscp-ipv6 dscp-ipv6-example
```

**Step-by-Step Procedure** The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see *Using the CLI Editor in Configuration Mode* in the [Junos OS CLI User Guide](#).

To configure CoS with a user-defined DSCP IPv6 BA classifier:

1. Configure CoS.  

```
[edit]
user@host# edit class-of-service
```
2. Define forwarding classes.  

```
[edit class-of-service]
user@host# set forwarding-classes queue 0 be-class
user@host# set forwarding-classes queue 1 ef-class
user@host# set forwarding-classes queue 2 af-class
user@host# set forwarding-classes queue 3 nc-class
```
3. Create a behavior aggregate classifier for DiffServ CoS.  

```
[edit class-of-service]
user@host# edit classifiers dscp-ipv6 dscp-ipv6-example
```
4. Import a DSCP IPv6 classifier.  

```
[edit class-of-service classifiers dscp-ipv6 dscp-ipv6-example]
user@host# set import default
```
5. Specify a best-effort forwarding class classifier.  

```
[edit class-of-service classifiers dscp-ipv6 dscp-ipv6-example]
user@host# set forwarding-class be-class loss-priority high code-points 000001
```
6. Specify an expedited forwarding class classifier.  

```
[edit class-of-service classifiers dscp-ipv6 dscp-ipv6-example]
user@host# set forwarding-class ef-class loss-priority high code-points 101111
```
7. Specify an assured forwarding class classifier.  

```
[edit class-of-service classifiers dscp-ipv6 dscp-ipv6-example]
user@host# set forwarding-class af-class loss-priority high code-points 001100
```
8. Specify a network control forwarding class classifier.

```
[edit class-of-service classifiers dscp-ipv6 dscp-ipv6-example]
user@host# set forwarding-class nc-class loss-priority high code-points 110001
```

9. Associate a user-defined classifier with an interface.

```
[edit class-of-service]
user@host# set interfaces ge-0/0/0 unit 0 classifiers dscp-ipv6 dscp-ipv6-example
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service
classifiers {
  dscp-ipv6 dscp-ipv6-example {
    import default;
    forwarding-class be-class {
      loss-priority high code-points 000001;
    }
    forwarding-class ef-class {
      loss-priority high code-points 101111;
    }
    forwarding-class af-class {
      loss-priority high code-points 001100;
    }
    forwarding-class nc-class {
      loss-priority high code-points 110001;
    }
  }
}
forwarding-classes {
  queue 0 be-class;
  queue 1 ef-class;
  queue 2 af-class;
  queue 3 nc-class;
}
interfaces {
  ge-0/0/0 {
    unit 0 {
      classifiers {
        dscp-ipv6 dscp-ipv6-example;
      }
    }
  }
}
```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

Confirm that the configuration is working properly.

- [Verifying the CoS with DSCP IPv6 BA Classifier Configuration on page 174](#)

### Verifying the CoS with DSCP IPv6 BA Classifier Configuration

---

**Purpose** Verify that the user-defined DSCP IPv6 BA classifier is associated with an interface.

**Action** From configuration mode, enter the **show class-of-service** command.

- Related Documentation**
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
  - [Understanding CoS with DSCP IPv6 BA Classifier on page 169](#)
  - [CoS Functions for IPv6 Traffic Overview on page 167](#)
  - [Understanding DSCP IPv6 Rewrite Rules on page 174](#)
  - [Example: Configuring CoS with DSCP IPv6 Rewrite Rules on page 175](#)

## Understanding DSCP IPv6 Rewrite Rules

---

After Junos OS CoS processing, a rewrite rule maps the forwarding class and loss priority after Junos OS CoS processing to a corresponding DSCP value specified in the rule. Typically, you use rewrite rules to alter the CoS values in outgoing packets to meet the requirements of the targeted peer.

You can use the CLI show command to display the configuration for the CoS classifiers. The following command shows the configuration of the default DSCP IPv6 rewrite rule:

```
user@host# show class-of-service rewrite-rule type dscp-ipv6
Rewrite rule: dscp-ipv6-default, Code point type: dscp-ipv6, Index: 32
  Forwarding class      Loss priority      Code point
  best-effort           low               000000
  best-effort           high             000000
  expedited-forwarding low               101110
  expedited-forwarding high             101110
  assured-forwarding   low               001010
  assured-forwarding   high             001100
  network-control      low               110000
  network-control      high             111000
```

- Related Documentation**
- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
  - [Example: Configuring CoS with DSCP IPv6 Rewrite Rules on page 175](#)
  - [CoS Functions for IPv6 Traffic Overview on page 167](#)
  - [Understanding CoS with DSCP IPv6 BA Classifier on page 169](#)
  - [Example: Configuring CoS with DSCP IPv6 BA Classifiers on page 171](#)

## Example: Configuring CoS with DSCP IPv6 Rewrite Rules

This example shows how to associate an interface with a default or user-defined DSCP IPv6 rewrite rule. Typically, you use rewrite rules to alter CoS values in outgoing packets to meet the requirements of the targeted peer.

- [Requirements on page 175](#)
- [Overview on page 175](#)
- [Configuration on page 175](#)
- [Verification on page 177](#)

### Requirements

Before you begin, configure the ge-0/0/0 interface on the device for IPv6 and define your user-defined DSCP IPv6 rewrite rules.

### Overview

In this example, you configure CoS and create a user-defined rewrite rule called `rewrite-ipv6-dscps`. You then specify rewrite rules for the best-effort forwarding class as `be-class`, the expedited forwarding class as `ef-class`, the assured forwarding class as `af-class`, and the network control forwarding class as `nc-class`. Finally, you associate interface `ge-0/0/0` with the user-defined rule.

### Configuration

#### CLI Quick Configuration

To quickly configure this example, copy the following commands, paste them into a text file, remove any line breaks, change any details necessary to match your network configuration, and then copy and paste the commands into the CLI at the **[edit]** hierarchy level.

```
set class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps
set class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps forwarding-class be-class
  loss-priority low code-point 000000
set class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps forwarding-class be-class
  loss-priority high code-point 000001
set class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps forwarding-class ef-class
  loss-priority low code-point 101110
set class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps forwarding-class ef-class
  loss-priority high code-point 101111
set class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps forwarding-class af-class
  loss-priority low code-point 001010
set class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps forwarding-class af-class
  loss-priority high code-point 001100
set class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps forwarding-class nc-class
  loss-priority low code-point 110000
set class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps forwarding-class nc-class
  loss-priority high code-point 110001
set class-of-service interfaces ge-0/0/0 unit 0 rewrite-rules dscp rewrite-dscps
```

**Step-by-Step Procedure** The following example requires you to navigate various levels in the configuration hierarchy. For instructions on how to do that, see Using the CLI Editor in Configuration Mode in the [Junos OS CLI User Guide](#).

To configure a CoS with a user-defined DSCP IPv6 rewrite rule:

1. Configure CoS.  

```
[edit]
user@host# edit class-of-service
```
2. Create a user-defined rewrite rule.  

```
[edit class-of-service]
user@host# edit rewrite-rules dscp-ipv6 rewrite-ipv6-dscps
```
3. Specify rewrite rules for the best-effort forwarding class.  

```
[edit class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps]
user@host# set forwarding-class be-class loss-priority low code-point 000000
user@host# set forwarding-class be-class loss-priority high code-point 000001
```
4. Specify rewrite rules for the expedited-forwarding forwarding class.  

```
[edit class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps]
user@host# set forwarding-class ef-class loss-priority low code-point 101110
user@host# set forwarding-class ef-class loss-priority high code-point 101111
```
5. Specify rewrite rules for the assured-forwarding forwarding class.  

```
[edit class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps]
user@host# set forwarding-class af-class loss-priority low code-point 001010
user@host# set forwarding-class af-class loss-priority high code-point 001100
```
6. Specify rewrite rules for the network-control forwarding class.  

```
[edit class-of-service rewrite-rules dscp-ipv6 rewrite-ipv6-dscps]
user@host# set forwarding-class nc-class loss-priority low code-point 110000
user@host# set forwarding-class nc-class loss-priority high code-point 110001
```
7. Associate an interface with a user-defined rule.  

```
[edit class-of-service]
user@host# set interfaces ge-0/0/0 unit 0 rewrite-rules dscp rewrite-dscps
```

**Results** From configuration mode, confirm your configuration by entering the **show class-of-service** command. If the output does not display the intended configuration, repeat the configuration instructions in this example to correct it.

```
[edit]
user@host# show class-of-service
interfaces {
  ge-0/0/0 {
    unit 0 {
      rewrite-rules {
        dscp rewrite-dscps;
      }
    }
  }
}
```



```

rewrite-rules {
  dscp-ipv6 rewrite-ipv6-dscps {
    forwarding-class be-class {
      loss-priority low code-point 000000;
      loss-priority high code-point 000001;
    }
    forwarding-class ef-class {
      loss-priority low code-point 101110;
      loss-priority high code-point 101111;
    }
    forwarding-class af-class {
      loss-priority low code-point 001010;
      loss-priority high code-point 001100;
    }
    forwarding-class nc-class {
      loss-priority low code-point 110000;
      loss-priority high code-point 110001;
    }
  }
}

```

If you are done configuring the device, enter **commit** from configuration mode.

## Verification

Confirm that the configuration is working properly.

- [Verifying the CoS with DSCP IPv6 Rewrite Rule Configuration on page 177](#)

### Verifying the CoS with DSCP IPv6 Rewrite Rule Configuration

<b>Purpose</b>	Verify that the user-defined CoS with DSCP IPv6 rewrite rule is associated with an interface.
<b>Action</b>	From configuration mode, enter the <b>show class-of-service</b> command.
<b>Related Documentation</b>	<ul style="list-style-type: none"> <li>• <a href="#">Junos OS Feature Support Reference for SRX Series and J Series Devices</a></li> <li>• <a href="#">Understanding DSCP IPv6 Rewrite Rules on page 174</a></li> <li>• <a href="#">CoS Functions for IPv6 Traffic Overview on page 167</a></li> <li>• <a href="#">Understanding CoS with DSCP IPv6 BA Classifier on page 169</a></li> <li>• <a href="#">Example: Configuring CoS with DSCP IPv6 BA Classifiers on page 171</a></li> </ul>



## CHAPTER 15

# CoS and I/O Cards

- [PIR-Only and CIR Mode Overview on page 179](#)
- [Understanding Priority Propagation on page 181](#)
- [Understanding IOC Hardware Properties on page 182](#)
- [Understanding IOC Map Queues on page 184](#)
- [WRED on the IOC Overview on page 185](#)
- [MDRR on the IOC Overview on page 189](#)

### PIR-Only and CIR Mode Overview

---

The actual behavior of many CoS parameters, especially the shaping rate and guaranteed rate, depends on whether the physical interface is operating in one of the following modes:

- [PIR-only Mode on page 179](#)
- [CIR Mode on page 180](#)

### PIR-only Mode

In PIR-only (peak information rate) mode, one or more nodes perform shaping. The physical interface is in PIR-only mode if no child (or grandchild) node under the port has a guaranteed rate configured. The mode of the port is important because in PIR-only mode, the scheduling across the child nodes is in proportion to their shaping rates (PIRs) and not the guaranteed rates (CIRs). This can be important if the observed behavior is not what is anticipated.

In PIR-only mode, nodes cannot send if they are above the configured shaping rate. [Table 36 on page 179](#) shows the mapping between the configured priority and the hardware priority for PIR-only.

**Table 36: Internal Node Queue Priority for PIR-Only Mode**

Configured Priority	Hardware Priority
Strict-high	0
High	0
Medium-high	1

**Table 36: Internal Node Queue Priority for PIR-Only Mode (*continued*)**

Configured Priority	Hardware Priority
Medium-low	1
Low	2

## CIR Mode

In CIR (committed information rate) mode, one or more nodes applies a guaranteed rate and might perform shaping. A physical interface is in CIR mode if at least one child (or grandchild) node has a guaranteed rate configured. In addition, any child or grandchild node under the physical interface can have a shaping rate configured. Only the guaranteed rate matters. In CIR mode, nodes that do not have a guaranteed rate configured are assumed to have a very small guaranteed rate (queuing weight).

In CIR mode, the priority for each internal node depends on whether the highest active child node is above or below the guaranteed rate. [Table 37 on page 180](#) shows the mapping between the highest active child's priority and the hardware priority below and above the guaranteed rate.

**Table 37: Internal Node Queue Priority for CIR Mode**

Configured Priority of Highest Active Child Node	Hardware Priority Below Guaranteed Rate	Hardware Priority Above Guaranteed Rate
Strict-high	0	0
High	0	3
Medium-high	1	3
Medium-low	1	3
Low	2	3

### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Understanding Priority Propagation on page 181](#)
- [Understanding IOC Hardware Properties on page 182](#)
- [Understanding IOC Map Queues on page 184](#)
- [WRED on the IOC Overview on page 185](#)
- [MDRR on the IOC Overview on page 189](#)

## Understanding Priority Propagation

SRX5600 and SRX5800 devices with input/output cards (IOCs) perform priority propagation. Priority propagation is useful for mixed traffic environments when, for example, you want to make [“Understanding IOC Map Queues” on page 184](#) sure that the voice traffic of one customer does not suffer from the data traffic of another customer. Nodes and queues are always serviced in the order of their priority. The priority of a queue is decided by configuration (the default priority is low) in the scheduler. However, not all elements of hierarchical schedulers have direct priorities configured. Internal nodes, for example, must determine their priority in other ways.

The priority of any internal node is decided as follows:

- By the highest priority of an active child (interface sets only take the highest priority of their active children)
- Whether the node is above its configured guaranteed rate (CIR) or not (this is relevant only if the physical interface is in CIR mode)

Each queue has a configured priority and a hardware priority. [Table 38 on page 181](#) shows the usual mapping between the configured priority and the hardware priority.

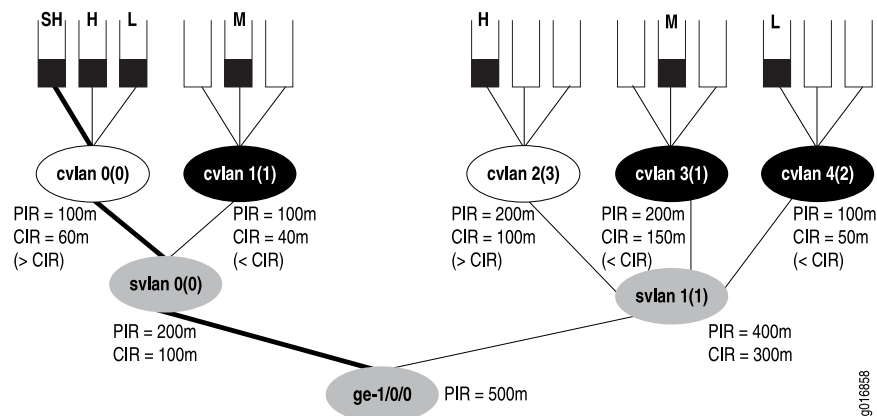
**Table 38: Queue Priority**

Configured Priority	Hardware Priority
Strict-high	0
High	0
Medium-high	1
Medium-low	1
Low	2

[Figure 10 on page 182](#) shows a physical interface with hierarchical schedulers configured. The configured priorities are shown for each queue at the top of the figure. The hardware priorities for each node are shown in parentheses. Each node also shows any configured shaping rate (PIR) or guaranteed rate (CIR) and whether or not the queues are above or below the CIR. The nodes are shown in one of the following three states:

- Above the CIR (clear)
- Below the CIR (dark)
- Condition where the CIR does not matter (gray)

Figure 10: Hierarchical Schedulers and Priorities



In Figure 10 on page 182, the strict high queue for C-VLAN 0 (cvlan 0) receives service first, even though the C-VLAN is above the configured CIR. Once that queue has been drained, and the priority of the node has become 3 instead of 0 (because of the lack of strict-high traffic), the system moves on to the medium queues (cvlan 1 and cvlan 3), draining them in a round-robin fashion where empty queues lose their hardware priority. The low queue on cvlan 4 (priority 2) is sent next because that mode is below the CIR. Then, the high queues on cvlan 0 and cvlan 2 (both now with priority 3) are drained in a round-robin fashion, and finally the low queue on cvlan 0 is drained (because svlan 0 has a priority of 3).

#### Related Documentation

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [PIR-Only and CIR Mode Overview on page 179](#)
- [Understanding IOC Hardware Properties on page 182](#)
- [Understanding IOC Map Queues on page 184](#)
- [WRED on the IOC Overview on page 185](#)
- [MDRR on the IOC Overview on page 189](#)

## Understanding IOC Hardware Properties

On SRX5600 and SRX5800 devices, two IOCs (40x1GE IOC and 4x10GE IOC) are supported on which you can configure schedulers and queues. You can configure 15 VLAN sets per Gigabit Ethernet (40x1GE IOC) port and 255 VLAN sets per 10-Gigabit Ethernet (4x10GE IOC) port. The IOC performs priority propagation from one hierarchy level to another, and drop statistics are available on the IOC per color per queue instead of just per queue.

SRX5600 and SRX5800 devices with IOCs have Packet Forwarding Engines that can support up to 512 MB of frame memory, and packets are stored in 512-byte frames. [Table 39 on page 183](#) compares the major properties of the Packet Forwarding Engine within the IOC.

Table 39: Packet Forwarding Engine Properties within 40x1GE IOC and 4x10GE IOC

Feature	PFE Within 40x1GE IOC and 4x10GE IOC
Number of usable queues	16,000
Number of shaped logical interfaces	2,000 with 8 queues each, or 4,000 with 4 queues each.
Number of hardware priorities	4
Priority propagation	Yes
Dynamic mapping	Yes: schedulers per port are not fixed.
Drop statistics	Per queue per color (PLP high, low)

Additionally, the IOC features also support hierarchical weighted random early detection (WRED).

The IOC supports the following hierarchical scheduler characteristics:

- Shaping at the physical interface level
- Shaping and scheduling at the service VLAN interface set level
- Shaping and scheduling at the customer VLAN logical interface level
- Scheduling at the queue level

The IOC supports the following features for scalability:

- 16,000 queues per PFE
- 4 PFEs per IOC
  - 4000 schedulers at logical interface level (level 3) with 4 queues each
  - 2000 schedulers at logical interface level (level 3) with 8 queues each
- 255 schedulers at the interface set level (level 2) per 1-port PFE on a 10-Gigabit Ethernet IOC (4x10GE IOC )
- 15 schedulers at the interface set level (level 2) per 10-port PFE on a 1-Gigabit Ethernet IOC (40x1GE IOC )
- About 400 milliseconds of buffer delay (this varies by packet size and if large buffers are enabled)
- 4 levels of priority (strict-high, high, medium, and low)



**NOTE:** The exact option for a transmit-rate (transmit-rate rate exact) is not supported on the IOCs on SRX Series devices.

**Related Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [PIR-Only and CIR Mode Overview on page 179](#)
- [Understanding Priority Propagation on page 181](#)
- [Understanding IOC Map Queues on page 184](#)
- [WRED on the IOC Overview on page 185](#)
- [MDRR on the IOC Overview on page 189](#)

---

## Understanding IOC Map Queues

The manner in which the IOC maps a queue to a scheduler depends on whether 8 queues or 4 queues are configured. By default, a scheduler at level 3 has 4 queues. Level 3 scheduler X controls queue  $X*4$  to  $X*4+3$ , so that scheduler 100 (for example) controls queues 400 to 403. However, when 8 queues per scheduler are enabled, the odd-numbered schedulers are disabled, allowing twice the number of queues per subscriber as before. With 8 queues, level 3 scheduler X controls queue  $X*4$  to  $X*4+7$ , so that scheduler 100 (for example) now controls queues 400 to 407.

You configure the **max-queues-per-interface** statement to set the number of queues at 4 or 8 at the FPC level of the hierarchy. Changing this statement will result in a restart of the FPC.

The IOC maps level 3 (customer VLAN) schedulers in groups to level 2 (service VLAN) schedulers. Sixteen contiguous level 3 schedulers are mapped to level 2 when 4 queues are enabled, and 8 contiguous level 3 schedulers are mapped to level 2 when 8 queues are enabled. All the schedulers in the group should use the same queue priority mapping. For example, if the queue priorities of one scheduler are high, medium, and low, all members of the group should have the same queue priority.

Groups at level 3 to level 2 can be mapped at any time. However, a group at level 3 can only be unmapped from a level 2 scheduler, and only if all the schedulers in the group are free. Once unmapped, a level 3 group can be remapped to any level 2 scheduler. There is no restriction on the number of level 3 groups that can be mapped to a particular level 2 scheduler. There can be 256 level 3 groups, but fragmentation of the scheduler space can reduce the number of schedulers available. In other words, there are scheduler allocation patterns that might fail even though there are free schedulers.

In contrast to level 3 to level 2 mapping, the IOC maps level 2 (service VLAN) schedulers in a fixed mode to level 1 (physical interface) schedulers. On 40-port Gigabit Ethernet IOCs, there are 16 level 1 schedulers, and 10 of these are used for the physical interfaces. There are 256 level 2 schedulers, or 16 per level 1 schedulers. A level 1 scheduler uses level schedulers  $X*16$  through  $X*16+15$ . Therefore level 1 scheduler 0 uses level 2 schedulers 0 through 15, level 1 scheduler 1 uses level 2 schedulers 16 through 31, and so on. On 4-port 10-Gigabit Ethernet PICs, there is one level 1 scheduler for the physical interface, and 256 level 2 schedulers are mapped to the single level 1 scheduler.

The maximum number of level 3 (customer VLAN) schedulers that can be used is 4076 (4 queues) or 2028 (8 queues) for the 10-port Gigabit Ethernet Packet Forwarding Engine



and 4094 (4 queues) or 2046 (8 queues) for the 10-Gigabit Ethernet Packet Forwarding Engine.

**Related Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Junos OS CLI Reference](#)
- [PIR-Only and CIR Mode Overview on page 179](#)
- [Understanding Priority Propagation on page 181](#)
- [Understanding IOC Hardware Properties on page 182](#)
- [WRED on the IOC Overview on page 185](#)
- [MDRR on the IOC Overview on page 189](#)

## WRED on the IOC Overview

Shaping to drop out-of-profile traffic is done on the IOC at all levels except the queue level. However, weighed random early discard (WRED) is done at the queue level with much the same result. With WRED, the decision to drop or send the packet is made before the packet is placed in the queue.

WRED shaping on the IOC involves two levels. The probabilistic drop region establishes a minimum and a maximum queue depth. Below the minimum queue depth, the drop probability is 0 (send). Above the maximum level, the drop probability is 100 (certainty).

There are four drop profiles associated with each queue. These correspond to each of four loss priorities (low, medium-low, medium-high, and high). Sixty-four sets of four drop profiles are available (32 for ingress and 32 for egress). In addition, there are eight WRED scaling profiles in each direction.

An example of an IOC drop profile for expedited forwarding traffic is as follows:

```
[edit class-of-service drop-profiles]
drop-ef {
  fill-level 20 drop-probability 0; # Minimum Q depth
  fill-level 100 drop-probability 100; # Maximum Q depth
}
```



**NOTE:** You can specify only two fill levels for the IOC.

You can configure the **interpolate** statement, but only two fill levels are used. The **delay-buffer-rate** statement in the traffic control profile determines the maximum queue size. This delay buffer rate is converted to packet delay buffers, where one buffer is equal to 512 bytes. For example, at 10 Mbps, the IOC will allocate 610 delay buffers when the delay buffer rate is set to 250 milliseconds. The WRED threshold values are specified in terms of absolute buffer values.

The WRED scaling factor multiplies all WRED thresholds (both minimum and maximum) by the value specified. There are eight values in all: 1, 2, 4, 8, 16, 32, 64, and 128. The WRED

scaling factor is chosen to best match the user-configured drop profiles. This is done because the hardware supports only certain values of thresholds (all values must be a multiple of 16). So if the configured value of a threshold is 500 (for example), the multiple of 16 is 256 and the scaling factor applied is 2, making the value 512, which allows the value of 500 to be used. If the configured value of a threshold is 1500, the multiple of 16 is 752 and the scaling factor applied is 2, making the value 1504, which allows the value of 1500 to be used.

Hierarchical RED is used to support the oversubscription of the delay buffers (WRED is configured only at the queue, physical interface, and PIC levels). Hierarchical RED works with WRED as follows:

- If any level accepts the packet (the queue depth is less than the minimum buffer levels), this level accepts the packet.
- If any level probabilistically drops the packet, then this level drops the packet.

However, these rules might lead to the accepting of packets under loaded conditions that might otherwise have been dropped. In other words, the logical interface will accept packets if the physical interface is not congested.

Because of the limits placed on shaping thresholds used in the hierarchy, there is a granularity associated with the IOCs. The shaper accuracies differ at various levels of the hierarchy:

- Level 3
- Level 2
- Level 1

Shapers at the logical interface level (level 3) are more accurate than shapers at the interface set level (level 2) or at the port level (level 1).

This section contains the following topics:

- [Shapers at the Logical Interface Level \(Level 3\) on page 186](#)
- [Shapers at the Interface Set Level \(Level 2\) on page 188](#)
- [Shapers at the Port Level \(Level 1\) on page 188](#)

## Shapers at the Logical Interface Level (Level 3)

Because of the limits placed on shaping thresholds used in the hierarchy, there is a granularity associated with the IOCs. The shaper accuracies differ at various levels of the hierarchy, with shapers at the logical interface level (level 3) being more accurate than shapers at the interface set level (level 2) or at the port level (level 1). [Table 40 on page 187](#) shows the accuracy of the logical interface shaper at various speeds for Ethernet ports operating at 1 Gbps.

**Table 40: Shaper Accuracy of 1-Gbps Ethernet at the Logical Interface Level**

Range of Logical Interface Shaper	Step Granularity
Up to 4.096 Mbps	16 Kbps
4.096 to 8.192 Mbps	32 Kbps
8.192 to 16.384 Mbps	64 Kbps
16.384 to 32.768 Mbps	128 Kbps
32.768 to 65.535 Mbps	256 Kbps
65.535 to 131.072 Mbps	512 Kbps
131.072 to 262.144 Mbps	1024 Kbps
262.144 to 1 Gbps	4096 Kbps

[Table 41 on page 187](#) shows the accuracy of the logical interface shaper at various speeds for Ethernet ports operating at 10 Gbps.

**Table 41: Shaper Accuracy of 10-Gbps Ethernet at the Logical Interface Level**

Range of Logical Interface Shaper	Step Granularity
Up to 10.24 Mbps	40 Kbps
10.24 to 20.48 Mbps	80 Kbps
10.48 to 40.96 Mbps	160 Kbps
40.96 to 81.92 Mbps	320 Kbps
81.92 to 163.84 Mbps	640 Kbps
163.84 to 327.68 Mbps	1280 Kbps
327.68 to 655.36 Mbps	2560 Kbps
655.36 to 2611.2 Mbps	10240 Kbps
2611.2 to 5222.4 Mbps	20480 Kbps
5222.4 to 10 Gbps	40960 Kbps

## Shapers at the Interface Set Level (Level 2)

Table 42 on page 188 shows the accuracy of the interface set shaper at various speeds for Ethernet ports operating at 1 Gbps.

**Table 42: Shaper Accuracy of 1-Gbps Ethernet at the Interface Set Level**

Range of Interface Set Shaper	Step Granularity
Up to 20.48 Mbps	80 Kbps
20.48 Mbps to 81.92 Mbps	320 Kbps
81.92 Mbps to 327.68 Mbps	1.28 Mbps
327.68 Mbps to 1 Gbps	20.48 Mbps

Table 43 on page 188 shows the accuracy of the interface set shaper at various speeds for Ethernet ports operating at 10 Gbps.

**Table 43: Shaper Accuracy of 10-Gbps Ethernet at the Interface Set Level**

Range of Interface Set Shaper	Step Granularity
Up to 128 Mbps	500 Kbps
128 Mbps to 512 Mbps	2 Mbps
512 Mbps to 2.048 Gbps	8 Mbps
2.048 Gbps to 10 Gbps	128 Mbps

## Shapers at the Port Level (Level 1)

Table 44 on page 188 shows the accuracy of the physical port shaper at various speeds for Ethernet ports operating at 1 Gbps.

**Table 44: Shaper Accuracy of 1-Gbps Ethernet at the Physical Port Level**

Range of Physical Port Shaper	Step Granularity
Up to 64 Mbps	250 Kbps
64 Mbps to 256 Mbps	1 Mbps
256 Mbps to 1 Gbps	4 Mbps

Table 45 on page 189 shows the accuracy of the physical port shaper at various speeds for Ethernet ports operating at 10 Gbps.

**Table 45: Shaper Accuracy of 10-Gbps Ethernet at the Physical Port Level**

Range of Physical Port Shaper	Step Granularity
Up to 640 Mbps	2.5 Mbps
640 Mbps to 2.56 Gbps	10 Mbps
2.56 Gbps to 10 Gbps	40 Mbps

**Related Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Junos OS CLI Reference](#)
- [PIR-Only and CIR Mode Overview on page 179](#)
- [Understanding Priority Propagation on page 181](#)
- [Understanding IOC Hardware Properties on page 182](#)
- [Understanding IOC Map Queues on page 184](#)
- [MDRR on the IOC Overview on page 189](#)

**MDRR on the IOC Overview**

The guaranteed rate CIR at the interface set level is implemented by using modified deficit round-robin (MDRR). The IOC hardware provides four levels of strict priority. There is no restriction on the number of queues for each priority. MDRR is used among queues of the same priority. Each queue has one priority when it is under the guaranteed rate and another priority when it is over the guaranteed rate but still under the shaping rate PIR. The IOC hardware implements the priorities with 256 service profiles. Each service profile assigns eight priorities for eight queues. One set is for logical interfaces under the guaranteed rate and another set is for logical interfaces over the guaranteed rate but under the shaping rate. Each service profile is associated with a group of 16 level 3 schedulers, so there is a unique service profile available for all 256 groups at level 3, giving 4,096 logical interfaces.

Junos OS provides three priorities for traffic under the guaranteed rate and one reserved priority for traffic over the guaranteed rate that is not configurable. Junos OS provides three priorities when there is no guaranteed rate configured on any logical interface.

[Table 46 on page 189](#) shows the relationship between Junos OS priorities and the IOC hardware priorities below and above the guaranteed rate CIR.

**Table 46: Junos Priorities Mapped to IOC Hardware Priorities**

Junos OS Priority	IOC Hardware Priority Below Guaranteed Rate	IOC Hardware Priority Above Guaranteed Rate
Strict-high	High	High
High	High	Low

Table 46: Junos Priorities Mapped to IOC Hardware Priorities (*continued*)

Junos OS Priority	IOC Hardware Priority Below Guaranteed Rate	IOC Hardware Priority Above Guaranteed Rate
Medium-high	Medium-high	Low
Medium-low	Medium-high	Low
Low	Medium-low	Low

The Junos OS parameters are set in the scheduler map:

```
[edit class-of-service schedulers]
best-effort-scheduler {
  transmit-rate percent 30; # if no shaping rate
  buffer-size percent 30;
  priority high;
}
expedited-forwarding-scheduler {
  transmit-rate percent 40; # if no shaping rate
  buffer-size percent 40;
  priority strict-high;
}
```



**NOTE:** The use of both a shaping rate and a guaranteed rate at the interface set level (level 2) is not supported.

MDRR is provided at three levels of the scheduler hierarchy of the IOC with a granularity of 1 through 255. There are 64 MDRR profiles at the queue level, 16 at the interface set level, and 32 at the physical interface level.

Queue transmit rates are used for queue-level MDRR profile weight calculation. The queue MDRR weight is calculated differently based on the mode set for sharing excess bandwidth. If you configure the **equal** option for excess bandwidth, then the queue MDRR weight is calculated as:

$$\text{Queue weight} = (255 * \text{Transmit-rate-percentage}) / 100$$

If you configure the **proportional** option for excess bandwidth, which is the default, then the queue MDRR weight is calculated as:

$$\text{Queue weight} = \text{Queue-transmit-rate} / \text{Queue-base-rate}, \text{ where}$$

$$\text{Queue-transmit-rate} = (\text{Logical-interface-rate} * \text{Transmit-rate-percentage}) / 100, \text{ and}$$

$$\text{Queue-base-rate} = \text{Excess-bandwidth-proportional-rate} / 255$$

To configure the way that the IOC should handle excess bandwidth, configure the **excess-bandwidth-share** statement at the [edit interface-set *interface-set-name*] hierarchy level. By default, the excess bandwidth is set to **proportional** with a default value of 32.64 Mbps. In this mode, the excess bandwidth is shared in the ratio of the logical interface

shaping rates. If set to **equal**, the excess bandwidth is shared equally among the logical interfaces.

The following example sets the excess bandwidth sharing to proportional at a rate of 100 Mbps with a shaping rate of 80 Mbps:

```
[edit interface-set example-interface-set]
excess-bandwidth-share proportional 100m;
output-traffic-control-profile PIR-80Mbps;
```

Shaping rates established at the logical interface level are used to calculate the MDRR weights used at the interface set level. The 16 MDRR profiles are set to initial values, and the closest profile with rounded values is chosen. By default, the physical port MDRR weights are preset to the full bandwidth on the interface.

**Related  
Documentation**

- [Junos OS Feature Support Reference for SRX Series and J Series Devices](#)
- [Junos OS CLI Reference](#)
- [PIR-Only and CIR Mode Overview on page 179](#)
- [Understanding Priority Propagation on page 181](#)
- [Understanding IOC Hardware Properties on page 182](#)
- [Understanding IOC Map Queues on page 184](#)
- [WRED on the IOC Overview on page 185](#)





## PART 6

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- [Index on page 195](#)



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