

# Queue-Level Bandwidth Sharing on EX9200 Switches



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# About the Documentation

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## Documentation and Release Notes

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To obtain the most current version of all Juniper Networks® technical documentation, see the product documentation page on the Juniper Networks website at <http://www.juniper.net/techpubs/>.

If the information in the latest release notes differs from the information in the documentation, follow the product Release Notes.

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## Supported Platforms

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For the features described in this document, the following platforms are supported:

- EX Series

## Using the Examples in This Manual

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If you want to use the examples in this manual, you can use the **load merge** or the **load merge relative** command. These commands cause the software to merge the incoming configuration into the current candidate configuration. The example does not become active until you commit the candidate configuration.

If the example configuration contains the top level of the hierarchy (or multiple hierarchies), the example is a *full example*. In this case, use the **load merge** command.

If the example configuration does not start at the top level of the hierarchy, the example is a *snippet*. In this case, use the **load merge relative** command. These procedures are described in the following sections.

## Merging a Full Example

To merge a full example, follow these steps:

1. From the HTML or PDF version of the manual, copy a configuration example into a text file, save the file with a name, and copy the file to a directory on your routing platform.

For example, copy the following configuration to a file and name the file **ex-script.conf**. Copy the **ex-script.conf** file to the **/var/tmp** directory on your routing platform.

```
system {
  scripts {
    commit {
      file ex-script.xml;
    }
  }
}
interfaces {
  fxp0 {
    disable;
    unit 0 {
      family inet {
        address 10.0.0.1/24;
      }
    }
  }
}
```

2. Merge the contents of the file into your routing platform configuration by issuing the **load merge** configuration mode command:

```
[edit]
user@host# load merge /var/tmp/ex-script.conf
load complete
```

## Merging a Snippet

To merge a snippet, follow these steps:

1. From the HTML or PDF version of the manual, copy a configuration snippet into a text file, save the file with a name, and copy the file to a directory on your routing platform.

For example, copy the following snippet to a file and name the file **ex-script-snippet.conf**. Copy the **ex-script-snippet.conf** file to the **/var/tmp** directory on your routing platform.

```
commit {
  file ex-script-snippet.xml; }
```

2. Move to the hierarchy level that is relevant for this snippet by issuing the following configuration mode command:



```
[edit]
user@host# edit system scripts
[edit system scripts]
```

3. Merge the contents of the file into your routing platform configuration by issuing the **load merge relative** configuration mode command:

```
[edit system scripts]
user@host# load merge relative /var/tmp/ex-script-snippet.conf
load complete
```

For more information about the **load** command, see the *CLI User Guide*.

## Documentation Conventions

Table 1 on page ix defines 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.
	Tip	Indicates helpful information.
	Best practice	Alerts you to a recommended use or implementation.

Table 2 on page ix 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>

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

Convention	Description	Examples
Fixed-width text like this	Represents output that appears on the terminal screen.	<pre>user@host&gt; show chassis alarms</pre> <p>No alarms currently active</p>
<i>Italic text like this</i>	<ul style="list-style-type: none"> <li>Introduces or emphasizes important new terms.</li> <li>Identifies guide 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 CLI User 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.	<p>Configure the machine's domain name:</p> <pre>[edit] root@# set system domain-name domain-name</pre>
Text like this	Represents names of configuration statements, commands, files, and directories; 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 <code>[edit protocols ospf area area-id]</code> hierarchy level.</li> <li>The console port is labeled <b>CONSOLE</b>.</li> </ul>
< > (angle brackets)	Encloses 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   multicast</b> <b>(string1   string2   string3)</b>
# (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)	Encloses a variable for which you can substitute one or more values.	<b>community name members [ community-ids ]</b>
Indentation and braces ( { } )	Identifies a level in the configuration hierarchy.	<pre>[edit] routing-options {   static {     route default {       nexthop address;       retain;     }   } }</pre>
;(semicolon)	Identifies a leaf statement at a configuration hierarchy level.	
<b>GUI Conventions</b>		
<b>Bold text like this</b>	Represents 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>

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

Convention	Description	Examples
> (bold right angle bracket)	Separates levels in a hierarchy of menu selections.	In the configuration editor hierarchy, select <b>Protocols&gt;Ospf</b> .

## Documentation Feedback

We encourage you to provide feedback, comments, and suggestions so that we can improve the documentation. You can provide feedback by using either of the following methods:

- Online feedback rating system—On any page at the Juniper Networks Technical Documentation site at <http://www.juniper.net/techpubs/index.html>, simply click the stars to rate the content, and use the pop-up form to provide us with information about your experience. Alternately, you can use the online feedback form at <https://www.juniper.net/cgi-bin/docbugreport/>.
- E-mail—Send your comments to [techpubs-comments@juniper.net](mailto:techpubs-comments@juniper.net). Include the document or topic name, URL or page number, and software version (if applicable).

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Technical product support is available through the Juniper Networks Technical Assistance Center (JTAC). If you are a customer with an active J-Care or JNASC support contract, or are covered under warranty, and need post-sales technical support, you can access our tools and resources online or open a case with JTAC.

- 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.

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- Find CSC offerings: <http://www.juniper.net/customers/support/>
- Search for known bugs: <http://www2.juniper.net/kb/>
- 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:  
<http://kb.juniper.net/InfoCenter/>
- 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, see <http://www.juniper.net/support/requesting-support.html>.

## PART 1

# Overview

- [Bandwidth Sharing on page 3](#)



## CHAPTER 1

# Bandwidth Sharing

- [Bandwidth Sharing on Nonqueuing Packet Forwarding Engines Overview on page 3](#)

## **Bandwidth Sharing on Nonqueuing Packet Forwarding Engines Overview**

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You can configure bandwidth sharing rate limits, excess rate, and excess priority at the queue level on the following Juniper Networks routers and switches:

- EX Series switches
- M120 Multiservice Edge Router (rate limit and excess priority only; excess rate is not configured by the user)
- M320 router with Enhanced FPCs (rate limit, excess rate, and excess priority)
- MX Series 3D Universal Edge Router with nonqueuing DPCs (rate limit, excess rate, and excess priority)

You configure rate limits when you have a concern that low-latency packets (such as high or strict-high priority packets for voice) might starve low-priority and medium-priority packets. In Junos OS, the low latency queue is implemented by rate-limiting packets to the transmit bandwidth. The rate-limiting is performed immediately before queuing the packet for transmission. All packets that exceed the rate limit are not queued, but dropped.

By default, if the excess priority is not configured for a queue, the excess priority will be the same as the normal queue priority. If none of the queues have an excess rate configured, then the excess rate will be the same as the transmit rate percentage. If at least one of the queues has an excess rate configured, then the excess rate for the queues that do not have an excess rate configured will be set to zero.

When the physical interface is on queuing hardware such as the IQ, IQ2, or IQE PICs, or MX Series routers queuing DPCs or EX Series switches, these features are dependent on the PIC (or queuing DPC in the case of the MX Series router) configuration.

You cannot configure both rate limits and buffer sizes on these Packet Forwarding Engines.

Four levels of excess priorities are supported: low, medium-low, medium-high, and high.



.....

**NOTE:** Rate limiting is implemented differently on Enhanced Queuing DPCs and non-queuing Packet Forwarding Engines. On Enhanced Queuing DPCs, rate-limiting is implemented using a single rate two color policer. On non-queuing Packet Forwarding Engines, rate-limiting is achieved by shaping the queue to the transmit rate and keeping the queue delay buffers small to prevent too many packets from being queued once the shaping rate is reached.

.....



## PART 2

# Configuration

- [Configuration Task on page 7](#)
- [Example on page 9](#)



## CHAPTER 2

# Configuration Task

- [Configuring Rate Limits on Nonqueuing Packet Forwarding Engines on page 7](#)

## Configuring Rate Limits on Nonqueuing Packet Forwarding Engines

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On non-queuing Packet Forwarding Engines, rate-limiting is achieved by shaping the queue to the transmit rate and keeping the queue delay buffers small to prevent too many packets from being queued once the shaping rate is reached. To configure rate limits for non-queuing Packet Forwarding Engines, include the **transmit-rate** statement at the **[edit class-of-service schedulers *scheduler-name*]** hierarchy level.



**NOTE:** Rate limiting is implemented differently on MPCs and Enhanced Queuing DPCs than on non-queuing Packet Forwarding Engines. On MPCs and Enhanced Queuing DPCs, rate-limiting is implemented using a single-rate two-color policer. See *Example: Limiting Outbound Traffic Within Your Network by Configuring an Egress Single-Rate Two-Color Policer and Configuring Multifield Classifiers* for an example of configuring a single-rate two-color policer to rate limit traffic.

### Configuring the Schedulers

The following example configures schedulers, forwarding classes, and a scheduler map for a rate-limited interface.

```
[edit class-of-service schedulers]
scheduler-1 {
  transmit-rate percent 20 rate-limit;
  priority high;
}
scheduler-2 {
  transmit-rate percent 10 rate-limit;
  priority strict-high;
}
scheduler-3 {
  transmit-rate percent 40;
  priority medium-high;
}
scheduler-4 {
  transmit-rate percent 30;
  priority medium-high;
}
```

**Configuring the  
Forwarding Classes**

```
[edit class-of-service]
forwarding-classes {
  class cp_000 queue-num 0;
  class cp_001 queue-num 1;
  class cp_010 queue-num 2;
  class cp_011 queue-num 3;
  class cp_100 queue-num 4;
  class cp_101 queue-num 5;
  class cp_110 queue-num 6;
  class cp_111 queue-num 7;
}
```

**Configuring the  
Scheduler Map**

```
[edit class-of-service scheduler-maps]
scheduler-map-1 {
  forwarding-class cp_000 scheduler scheduler-1;
  forwarding-class cp_001 scheduler scheduler-2;
  forwarding-class cp_010 scheduler scheduler-3;
  forwarding-class cp_011 scheduler scheduler-4;
}
```

**Applying the Scheduler  
Map to the Interface**

```
[edit class-of-service interfaces]
ge-1/0/0 {
  scheduler-map scheduler-map-1;
}
```

## CHAPTER 3

# Example

- [Excess Rate and Excess Priority Configuration Examples on page 9](#)

### Excess Rate and Excess Priority Configuration Examples

To configure the excess rate for nonqueuing Packet Forwarding Engines, include the *excess-rate* statement at the **[edit class-of-service schedulers *scheduler-name*]** hierarchy level.

To configure the excess priority for nonqueuing Packet Forwarding Engines, include the *excess-priority* statement at the **[edit class-of-service schedulers *scheduler-name*]** hierarchy level.

The relationship between the configured guaranteed rate, excess rate, guaranteed priority, excess priority, and offered load is not always obvious. The following tables show the expected throughput of a Gigabit Ethernet port with various bandwidth-sharing parameters configured on the queues.

The default behavior of a nonqueuing Gigabit Ethernet interface with multiple priority levels is shown in [Table 3 on page 9](#). All queues in the table get their guaranteed rate. The excess bandwidth is first offered to the excess high-priority queues. Because these use all available bandwidth, there is no remaining excess bandwidth for the low-priority queues.

**Table 3: Current Behavior with Multiple Priority Levels**

Queue	Guaranteed (Transmit) Rate	Guaranteed Priority	Excess Priority	Offered Load	Expected Throughput
Q0	20%	high	high	600 Mbps	$200 + 366.67 = 566.67$ Mbps
Q1	10%	high	high	500 Mbps	$100 + 183.33 = 283.33$ Mbps
Q2	10%	low	low	500 Mbps	$100 + 0 = 100$ Mbps
Q3	5%	low	low	500 Mbps	$50 + 0 = 50$ Mbps

The default behavior of a nonqueuing Gigabit Ethernet interface with the same priority levels is shown in [Table 4 on page 10](#). All queues in the table get their guaranteed rate.

Because all queues have the same excess priority, they share the excess bandwidth and each queue gets excess bandwidth in proportion to the transmit rate.

**Table 4: Current Behavior with Same Priority Levels**

Queue	Guaranteed (Transmit) Rate	Guaranteed Priority	Excess Priority	Offered Load	Expected Throughput
Q0	20%	high	high	500 Mbps	$200 + 244.44 = 444.44$ Mbps
Q1	10%	high	high	500 Mbps	$100 + 122.22 = 222.22$ Mbps
Q2	10%	high	high	500 Mbps	$100 + 122.22 = 222.22$ Mbps
Q3	5%	high	high	500 Mbps	$50 + 61.11 = 111.11$ Mbps

The default behavior of a nonqueuing Gigabit Ethernet interface with the at least one strict-high priority level is shown in [Table 5 on page 10](#). First the high priority and strict-high are serviced in a weighted round-robin fashion. The high priority queue gets its guaranteed bandwidth and the strict-high queue gets what remains. The high excess priority queue gets all the excess bandwidth.

**Table 5: Current Behavior with Strict-High Priority**

Queue	Guaranteed (Transmit) Rate	Guaranteed Priority	Excess Priority	Offered Load	Expected Throughput
Q0	20%	strict-high	X	500 Mbps	500 Mbps
Q1	10%	high	high	500 Mbps	$100 + 250 = 350$ Mbps
Q2	10%	low	low	500 Mbps	$100 + 0 = 100$ Mbps
Q3	5%	low	low	500 Mbps	$50 + 0 = 50$ Mbps

The default behavior of a nonqueuing Gigabit Ethernet interface with the at least one strict-high priority level and a higher offered load on Q0 is shown in [Table 6 on page 10](#). First the high priority and strict-high are serviced in a weighted round-robin fashion. The high priority queue gets its guaranteed bandwidth and the strict-high queue gets what remains. There is no excess bandwidth.

**Table 6: Strict-High Priority with Higher Load**

Queue	Guaranteed (Transmit) Rate	Guaranteed Priority	Excess Priority	Offered Load	Expected Throughput
Q0	20%	strict-high	X	1 Gbps	900 Mbps
Q1	10%	high	high	500 Mbps	$100 + 0 = 100$ Mbps
Q2	10%	low	low	500 Mbps	$0 + 0 = 0$ Mbps

Table 6: Strict-High Priority with Higher Load (*continued*)

Queue	Guaranteed (Transmit) Rate	Guaranteed Priority	Excess Priority	Offered Load	Expected Throughput
Q3	5%	low	low	500 Mbps	$0 + 0 = 0$ Mbps

Now consider the behavior of the queues with configured excess rates and excess priorities.

The behavior with multiple priority levels is shown in [Table 7 on page 11](#). All queues get the guaranteed rate. The excess bandwidth is first offered to the excess high priority queues and these consume all the bandwidth. There is no remaining excess bandwidth for low priority queues.

Table 7: Sharing with Multiple Priority Levels

Queue	Guaranteed (Transmit) Rate	Excess Rate	Guaranteed Priority	Excess Priority	Offered Load	Expected Throughput
Q0	20%	10%	high	high	500 Mbps	$200 + 275 = 475$ Mbps
Q1	10%	20%	high	low	500 Mbps	$100 + 0 = 100$ Mbps
Q2	10%	10%	low	high	500 Mbps	$100 + 275 = 275$ Mbps
Q3	5%	20%	low	low	500 Mbps	$50 + 0 = 50$ Mbps

The behavior with the same (high) priority levels is shown in [Table 8 on page 11](#). All queues get the guaranteed rate. Because all queues have the same excess priority, they share the excess bandwidth in proportion to their transmit rate.

Table 8: Sharing with the Same Priority Levels

Queue	Guaranteed (Transmit) Rate	Excess Rate	Guaranteed Priority	Excess Priority	Offered Load	Expected Throughput
Q0	20%	10%	high	high	500 Mbps	$200 + 91.67 = 291.67$ Mbps
Q1	10%	20%	high	high	500 Mbps	$100 + 183.33 = 283.33$ Mbps
Q2	10%	10%	high	high	500 Mbps	$100 + 91.67 = 191.67$ Mbps
Q3	5%	20%	high	high	500 Mbps	$50 + 183.33 = 233.33$ Mbps

The behavior with at least one strict-high priority level is shown in [Table 9 on page 12](#). The high priority and strict-high queues are serviced in a weighted round-robin fashion. The high priority queue gets its guaranteed rate and the strict-high queue gets the rest. The excess high-priority queue get all the excess bandwidth.

Table 9: Sharing with at Least One Strict-High Priority

Queue	Guaranteed (Transmit) Rate	Excess Rate	Guaranteed Priority	Excess Priority	Offered Load	Expected Throughput
Q0	20%	X	strict-high	X	500 Mbps	500 Mbps
Q1	10%	20%	high	low	500 Mbps	100 + 0 = 100 Mbps
Q2	10%	10%	low	high	500 Mbps	100 + 250 = 350 Mbps
Q3	5%	20%	low	low	500 Mbps	50 + 0 = 50 Mbps

The behavior with at least one strict-high priority level and a higher offered load is shown in [Table 10 on page 12](#). The high priority and strict-high queues are serviced in a weighted round-robin fashion. The high priority queue gets its guaranteed rate and the strict-high queue gets the rest. There is no excess bandwidth.

Table 10: Sharing with at Least One Strict-High Priority and Higher Load

Queue	Guaranteed (Transmit) Rate	Excess Rate	Guaranteed Priority	Excess Priority	Offered Load	Expected Throughput
Q0	20%	X	strict-high	X	900 Mbps	900 Mbps
Q1	10%	20%	high	low	500 Mbps	100 + 0 = 100 Mbps
Q2	10%	10%	low	high	500 Mbps	0 + 0 = 0 Mbps
Q3	5%	20%	low	low	500 Mbps	0 + 0 = 0 Mbps

The behavior with at least one strict-high priority level and a rate limit is shown in [Table 11 on page 12](#). Queue 0 and Queue 2 are rate limited, so the maximum bandwidth they are offered is the transmit bandwidth and they will not be offered any excess bandwidth. All other queues are offered the guaranteed bandwidth and the excess is shared by the non-rate-limited queues.

Table 11: Sharing with at Least One Strict-High Priority and Rate Limit

Queue	Guaranteed (Transmit) Rate	Rate Limit	Excess Rate	Guaranteed Priority	Excess Priority	Offered Load	Expected Throughput
Q0	20%	Yes	X	strict-high	X	500 Mbps	200 + 0 = 200 Mbps
Q1	10%	No	20%	high	low	500 Mbps	100 + 275 = 375 Mbps



Table 11: Sharing with at Least One Strict-High Priority and Rate Limit (*continued*)

Queue	Guaranteed (Transmit) Rate	Rate Limit	Excess Rate	Guaranteed Priority	Excess Priority	Offered Load	Expected Throughput
Q2	10%	Yes	10%	low	high	500 Mbps	100 + 0 = 100 Mbps
Q3	5%	No	20%	low	low	500 Mbps	50 + 275 = 325 Mbps

**Configuring the Schedulers**

The following example configures schedulers, forwarding classes, and a scheduler map for an interface with excess rates and excess priorities.

```
[edit class-of-service schedulers]
scheduler-1 {
  transmit-rate percent 20;
  priority high;
  excess-rate percent 10;
  excess-priority low;
}
scheduler-2 {
  transmit-rate percent 10;
  priority strict-high;
}
scheduler-3 {
  transmit-rate percent 10;
  priority medium-high;
  excess-rate percent 20;
  excess-priority high;
}
scheduler-4 {
  transmit-rate percent 5;
  priority medium-high;
  excess-rate percent 30;
  excess-priority low;
}
```

**Configuring the Forwarding Classes**

```
[edit class-of-service]
forwarding-classes {
  class cp_000 queue-num 0;
  class cp_001 queue-num 1;
  class cp_010 queue-num 2;
  class cp_011 queue-num 3;
  class cp_100 queue-num 4;
  class cp_101 queue-num 5;
  class cp_110 queue-num 6;
  class cp_111 queue-num 7;
}
```

**Configuring the Scheduler Map**

```
[edit class-of-service scheduler-maps]
scheduler-map-1 {
  forwarding-class cp_000 scheduler scheduler-1;
  forwarding-class cp_001 scheduler scheduler-2;
```

```
forwarding-class cp_010 scheduler scheduler-3;  
forwarding-class cp_011 scheduler scheduler-4;  
}
```

**Applying the Scheduler  
Map to the Interface**

```
[edit interfaces]  
ge-1/1/0 {  
  scheduler-map scheduler-map-1;  
  unit 0 {  
    family inet {  
      address 192.168.1.2/32;  
    }  
  }  
}
```