Configuring Queuing and Scheduling

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About Queuing and Scheduling

Traffic queuing is the ordering of packets and applies to both input and output of data. Device modules can support multiple queues, which you can use to control the sequencing of packets in different traffic classes. You can also set weighted random early detection (WRED) and tail-drop thresholds. The device drops packets only when the configured thresholds are exceeded.

Traffic scheduling is the methodical output of packets at a desired frequency to accomplish a consistent flow of traffic. You can apply traffic scheduling to different traffic classes to weight the traffic by priority.

The queuing and scheduling processes allow you to control the bandwidth that is allocated to the traffic classes so that you achieve the desired trade-off between throughput and latency for your network.

Modifying Class Maps

System-defined queuing class maps are provided.
The provided system-defined queuing class maps cannot be modified.

**Congestion Avoidance**

You can use the following methods to proactively avoid traffic congestion on the device:

- Apply WRED to TCP or non-TCP traffic.
- Apply tail drop to TCP or non-TCP traffic.

**Congestion Management**

For egress packets, you can choose one of the following congestion management methods:

- Specify a bandwidth that allocates a minimum data rate to a queue.
- Impose a minimum and maximum data rate on a class of traffic so that excess packets are retained in a queue to shape the output rate.
- Allocate all data for a class of traffic to a priority queue. The device distributes the remaining bandwidth among the other queues.

For information about configuring congestion management, see the Configuring WRED on Egress Queues section.

**Explicit Congestion Notification**

ECN is an extension to WRED that marks packets instead of dropping them when the average queue length exceeds a specific threshold value. When configured with the WRED ECN feature, routers and end hosts use this marking as a signal that the network is congested to slow down sending packets.

The ECN feature is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).

Enabling WRED and ECN on a class on a network-qos policy implies that WRED and ECN is enabled for all ports in the system.

On extended output queues (EOQ), the approximate fair-drop (AFD) feature for bandwidth management is always enabled. The WRED configuration is ignored on EOQs. The configuration for EOQs is based on the system queuing policy and not on the per port policy.
Traffic Shaping

Traffic shaping allows you to control the traffic going out of an interface in order to match its flow to the speed of the remote target interface and to ensure that the traffic conforms to policies contracted for it. You can shape traffic that adheres to a particular profile to meet downstream requirements. Traffic shaping eliminates bottlenecks in topologies with data-rate mismatches.

Traffic shaping regulates and smooths out the packet flow by imposing a maximum traffic rate for each port’s egress queue. Packets that exceed the threshold are placed in the queue and are transmitted later. Traffic shaping is similar to traffic policing, but the packets are not dropped. Because packets are buffered, traffic shaping minimizes packet loss (based on the queue length), which provides better traffic behavior for TCP traffic.

Using traffic shaping, you can control access to available bandwidth, ensure that traffic conforms to the policies established for it, and regulate the flow of traffic to avoid congestion that can occur when the egress traffic exceeds the access speed of its remote, target interface. For example, you can control access to the bandwidth when policy dictates that the rate of a given interface should not, on average, exceed a certain rate even though the access rate exceeds the speed.

Queue length thresholds are configured using the WRED configuration.

Note

Traffic shaping is not supported on ALE enabled device 40G front panel ports. When traffic shaping is configured for the system level, the setting is ignored and no error message is displayed. When traffic shaping commands are configured for the port level, the setting is rejected and an error message is displayed.

Licensing Requirements for Queuing and Scheduling

The following table shows the licensing requirements for this feature:

<table>
<thead>
<tr>
<th>Product</th>
<th>License Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cisco NX-OS</td>
<td>The QoS feature does not a require license. Any feature not included in a license package is bundled with the NX-OS image and is provided at no extra charge to you. For a complete explanation of the Cisco NX-OS licensing scheme, see the Cisco NX-OS Licensing Guide.</td>
</tr>
</tbody>
</table>

Prerequisites for Queuing and Scheduling

Queuing and scheduling have the following prerequisites:

- You must be familiar with using modular QoS CLI.
- You are logged on to the device.
Guidelines and Limitations

Queuing and scheduling have the following configuration guidelines and limitations:

- **show** commands with the `internal` keyword are not supported.
- The device supports a system-level queuing policy, so all ports in the system are impacted when you configure the queuing policy.
- A type queuing policy can be attached to the system or to individual interfaces for input or output traffic.
- Changes are disruptive. The traffic passing through ports of the specified port type experience a brief period of traffic loss. All ports of the specified type are affected.
- Performance can be impacted. If one or more ports of the specified type do not have a queuing policy applied that defines the behavior for the new queue, the traffic mapping to that queue might experience performance degradation.
- Traffic shaping might increase the latency of packets due to queuing because it falls back to store-and-forward mode when packets are queued.
- Traffic shaping is not supported on the Cisco Nexus 9300 ALE 40G ports. For more information on ALE 40G uplink ports, see the Limitations for ALE 40G Uplink Ports on the Cisco Nexus 9000 Series Switches.
- When configuring priority for one class map queue (SPQ), you need to configure the priority for QoS group 3. When configuring priority for more than one class map queue, you need to configure the priority on the higher numbered QoS groups. In addition, the QoS groups need to be adjacent to each other. For example, if you want to have two SPQs, you have to configure the priority on QoS group 3 and on QoS group 2.
- For the following Cisco Nexus platform switches, the lowest value that the egress shaper can manage, per queue, is 100 Mbps:
  - Cisco Nexus 9200 series switches
  - Cisco Nexus 9300-EX/FX/FX2 switches
  - Cisco Nexus 9700-EX/FX switches

Buffer-boost

The buffer-boost feature enables the line card to use extra buffers. This capability is enabled by default on line cards such as the N9K-X9564PX.

- The command to enable the buffer-boost feature is `buffer-boost`.
- The command to disable the buffer-boost feature is `no buffer-boost`.

Generally, Cisco recommends not to disable the buffer-boost feature. However, disabling the buffer-boost is necessary when there is a need to port channel two different member ports from N9K-X9636PQ based line cards and N9K-X9564PX based line cards. However, Cisco does not recommend to port channel such a configuration between ACI capable leaf line cards and standalone line cards.
Line cards like the N9K-X9636PQ and similar, do not offer the buffer-boost feature.

**Order of Resolution**

The following describes the order of resolution for the pause buffer configuration and the queue-limit for a priority-group.

- **Pause Buffer Configuration**
  The pause buffer configuration is resolved in the following order:
  - Interface ingress queuing policy (if applied and pause buffer configuration specified for that class).
  - System ingress queuing policy (if applied and pause buffer configuration specified for that class).
  - System network-QoS policy (if applied and pause buffer configuration specified for that class).
  - Default values with regards to the speed of the port.

- **Queue-limit for Priority-Group**
  The queue-limit for a priority-group is resolved in the following order:
  - Interface ingress queuing policy (if applied and queue-limit configuration specified for that class).
  - System ingress queuing policy (if applied and queue-limit configuration specified for that class).
  - The `hardware qos ing-pg-share` configuration provided value.
  - System default value.

**Ingress Queuing**

The following are notes about ingress queuing:

- No default system ingress queuing policy exists.
- The ingress queuing policy is used to override the specified pause buffer configuration.
- When downgrading to an earlier release of Cisco Nexus 9000 NX-OS, all ingress queuing configurations have to be removed.
- The ingress queuing feature is supported only on platforms where priority flow control is supported.

**Configuring Queuing and Scheduling**

Queuing and scheduling are configured by creating policy maps of type queuing that you apply to an egress interface. You can modify system-defined class maps, which are used in policy maps to define the classes of traffic to which you want to apply policies.

For information about configuring policy maps and class maps, see the "Using Modular QoS CLI" section.

You can configure the congestion-avoidance features, which include tail drop and WRED, in any queue.
You can configure one of the egress congestion management features, such as priority, traffic shaping, and bandwidth in output queues.

**Note**

WRED is not supported on ALE enabled device front panel 40G uplink ports. When WRED is configured for the system level, the setting is ignored and no error message is displayed. When WRED is configured for the port level, the setting is rejected and an error message is displayed.

The system-defined policy map, default-out-policy, is attached to all ports to which you do not apply a queuing policy map. The default policy maps cannot be configured.

### Configuring Type Queuing Policies

Type queuing policies for egress are used for scheduling and buffering the traffic of a specific system class. A type queuing policy is identified by its QoS group and can be attached to the system or to individual interfaces for input or output traffic.

**Note**

Ingress queuing policy is used to configure pause buffer thresholds. For more details, see the Priority Flow Control section.

#### SUMMARY STEPS

1. `configure terminal`
2. `policy-map type queuing policy-name`
3. `class type queuing class-name`
4. `priority`
5. `no priority`
6. `shape {kbps | mbps | gbps} burst size min minimum bandwidth`
7. `bandwidth percent percentage`
8. `no bandwidth percent percentage`
9. `priority level level`
10. `queue-limit queue size [dynamic dynamic threshold]`

#### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Step 2</strong> policy-map type queuing policy-name</td>
<td>Creates a named object that represents a set of policies that are to be applied to a set of traffic classes. Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.</td>
</tr>
<tr>
<td><strong>Step 3</strong> class type queuing class-name</td>
<td>Associates a class map with the policy map, and enters configuration mode for the specified system class.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 4</strong></td>
<td>priority</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Specifies that traffic in this class is mapped to a strict priority queue.</td>
</tr>
<tr>
<td><strong>Step 5</strong></td>
<td>no priority</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>(Optional) Removes the strict priority queuing from the traffic in this class.</td>
</tr>
<tr>
<td><strong>Step 6</strong></td>
<td>shape {kbps</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Specifies the burst size and minimum guaranteed bandwidth for this queue.</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>bandwidth percent percentage</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Assigns a weight to the class. The class will receive the assigned percentage of interface bandwidth if there are no strict-priority queues. If there are strict-priority queues, however, the strict-priority queues receive their share of the bandwidth first. The remaining bandwidth is shared in a weighted manner among the class configured with a bandwidth percent. For example, if strict-priority queues take 90 percent of the bandwidth, and you configure 75 percent for a class, the class will receive 75 percent of the remaining 10 percent of the bandwidth. <strong>Note</strong> Before you can successfully allocate bandwidth to the class, you must first reduce the default bandwidth configuration on class-default and class-fcoe.</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>no bandwidth percent percentage</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>(Optional) Removes the bandwidth specification from this class.</td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>priority level level</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>(Optional) Specifies the strict priority levels for the Cisco Nexus 9000 Series switches. These levels can be from 1 to 7.</td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>queue-limit queue size [dynamic dynamic threshold]</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>(Optional) Specifies either the static or dynamic shared limit available to the queue for Cisco Nexus 9000 Series switches. The static queue limit defines the fixed size to which the queue can grow. The dynamic queue limit allows the queue's threshold size to be decided depending on the number of free cells available, in terms of the alpha value. <strong>Note</strong> Cisco Nexus 9200 Series switches only support a class level dynamic threshold configuration with respect to the alpha value. This means that all ports in a class share the same alpha value.</td>
</tr>
</tbody>
</table>

**Configuring Congestion Avoidance**

You can configure congestion avoidance with tail drop or WRED features. Both features can be used in egress policy maps.
WRED and tail drop cannot be configured in the same class.

**Configuring Tail Drop on Egress Queues**

You can configure tail drop on egress queues by setting thresholds. The device drops any packets that exceed the thresholds. You can specify a threshold based on the queue size or buffer memory that is used by the queue.

**SUMMARY STEPS**

1. `configure terminal`
2. `hardware qos q-noise percent value`
3. `policy-map [type queuing] [match-first] [policy-map-name]`
4. `class type queuing class-name`
5. `queue-limit {queue-size [bytes | kbytes | mbytes] | dynamic value}`
6. (Optional) Repeat Steps 3 and 4 to assign tail drop thresholds for other queue classes.
7. `show policy-map [type queuing [policy-map-name | default-out-policy]]`
8. `copy running-config startup-config`

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> <code>configure terminal</code></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>switch# configure terminal switch(config)#</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> <code>hardware qos q-noise percent value</code></td>
<td>Tunes the random noise parameter. The default value is 20 percent.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>switch(config)# hardware qos q-noise percent 30</code></td>
<td>This command is supported for Cisco Nexus 9200 and 9300-EX Series switches beginning with Cisco NX-OS Release 7.0(3)I4(4).</td>
</tr>
<tr>
<td><strong>Step 3</strong> <code>policy-map [type queuing] [match-first] [policy-map-name]</code></td>
<td>Configures the policy map of type queuing and then enters policy-map mode for the policy-map name you specify. Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>switch(config)# policy-map type queuing shape_queues</code></td>
<td></td>
</tr>
<tr>
<td><code>switch(config-pmap-que)#</code></td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> <code>class type queuing class-name</code></td>
<td>Configures the class map of type queuing and then enters policy-map class queuing mode. Class queuing names are listed in the previous System-Defined Type queuing Class Maps table.</td>
</tr>
<tr>
<td><strong>Example:</strong> <code>switch(config-pmap-que)# class type queuing c-out-q1</code></td>
<td></td>
</tr>
<tr>
<td><code>switch(config-pmap-c-que)#</code></td>
<td></td>
</tr>
</tbody>
</table>
### Configuring Queuing and Scheduling

#### Configuring WRED on Egress Queues

You can configure WRED on egress queues to set minimum and maximum packet drop thresholds. The frequency of dropped packets increases as the queue size exceeds the minimum threshold. When the maximum threshold is exceeded, all packets for the queue are dropped.

**Note**  
WRED and tail drop cannot be configured in the same class.
AFD and WRED cannot be applied at the same time. Only one can be used in a system.

**SUMMARY STEPS**

1. configure terminal
2. policy-map type queuing {[match-first] policy-map-name}
3. class type queuing class-name
4. random-detect [minimum-threshold min-threshold {packets | bytes | kbytes | mbytes} maximum-threshold max-threshold {packets | bytes | kbytes | mbytes} drop-probability value weight value] [threshold {burst-optimized | mesh-optimized}] [ecn | non-ecn]
5. (Optional) Repeat Steps 3 and 4 to configure WRED for other queuing classes.

**DETAILED STEPS**

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td>switch(config)#</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>policy-map type queuing {[match-first] policy-map-name}</td>
<td>Configures the policy map of type queuing and then enters policy-map mode for the policy-map name you specify. Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.</td>
</tr>
<tr>
<td>Example:</td>
<td>switch(config)# policy-map type queuing pl</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>class type queuing class-name</td>
<td>Configures the class map of type queuing and then enters policy-map class queuing mode. Class queuing names are listed in the previous System-Defined Type queuing Class Maps table.</td>
</tr>
<tr>
<td>Example:</td>
<td>switch(config-pmap-que)# class type queuing c-out-q1</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td>random-detect [minimum-threshold min-threshold {packets</td>
<td>bytes</td>
</tr>
<tr>
<td>Example:</td>
<td>switch(config-pmap-c-que)# random-detect minimum-threshold 10 mbytes maximum-threshold 20 mbytes</td>
<td></td>
</tr>
<tr>
<td>Note</td>
<td>The minimum-threshold and maximum-threshold parameters are not supported on the Cisco Nexus 9300 and N9K-X9564TX and N9K-X9564PX line cards.</td>
<td></td>
</tr>
<tr>
<td>Step 5</td>
<td>(Optional) Repeat Steps 3 and 4 to configure WRED for other queuing classes.</td>
<td></td>
</tr>
</tbody>
</table>
Configuring Congestion Management

You can configure only one of the following congestion management methods in a policy map:

- Allocate a minimum data rate to a queue by using the `bandwidth` and `bandwidth remaining` commands.

- Allocate all data for a class of traffic to a priority queue by using the `priority` command. You can use the `bandwidth remaining` command to distribute remaining traffic among the nonpriority queues. By default, the system evenly distributes the remaining bandwidth among the nonpriority queues.

- Allocate a minimum and maximum data rate to a queue by using the `shape` command.

In addition to the congestion management feature that you choose, you can configure one of the following queue features in each class of a policy map:

- Tail drop thresholds based on the queue size and the queue limit usage. For more information, see Configuring Tail Drop on Egress Queues, on page 8.

- WRED for preferential packet drops. For more information, see the Configuring WRED on Egress Queues section.

**Note** WRED is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3).

Configuring Bandwidth and Bandwidth Remaining

You can configure the bandwidth and bandwidth remaining on the egress queue to allocate a minimum percentage of the interface bandwidth to a queue.

**Note** When a guaranteed bandwidth is configured, the priority queue must be disabled in the same policy map.

**SUMMARY STEPS**

1. `configure terminal`
2. `policy-map type queuing {[match-first] policy-map-name}`
3. `class type queuing class-name`
4. Assign a minimum rate of the interface bandwidth or assign the percentage of the bandwidth that remains:
   - Bandwidth percent:
     ```
     bandwidth {percent percent}
     ```
   - Bandwidth remaining percent:
     ```
     bandwidth remaining percent percent
     ```
5. (Optional) Repeat Steps 3 and 4 to assign tail drop thresholds for other queue classes.
6. `exit`
7. `show policy-map [type queuing [policy-map-name | default-out-policy]]`
8. `copy running-config startup-config`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong></td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><code>configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td></td>
</tr>
<tr>
<td><code>switch# configure terminal</code></td>
<td></td>
</tr>
<tr>
<td><code>switch(config)#</code></td>
<td></td>
</tr>
</tbody>
</table>

**Step 2**

Configure the policy map of type queuing and then enters policy-map mode for the policy-map name you specify. Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.

- `policy-map type queuing { [match-first] policy-map-name }`

**Example:**

```
switch(config)# policy-map type queuing shape_queues
switch(config-pmap-que)#
```

**Step 3**

Configure the class map of type queuing and then enters policy-map class queuing mode. Class queuing names are listed in the previous System-Defined Type queuing Class Maps table.

- `class type queuing class-name`

**Example:**

```
switch(config-pmap-que)# class type queuing c-out-q1
switch(config-pmap-c-que)#
```

**Step 4**

Assign a minimum rate of the interface bandwidth or assign the percentage of the bandwidth that remains:

- Bandwidth percent:
  - `bandwidth { percent percent }`
- Bandwidth remaining percent:
  - `bandwidth remaining percent percent`

**Example:**

```
switch(config-pmap-c-que)# bandwidth percent
25
```

```
switch(config-pmap-c-que)# bandwidth remaining percent
25
```

**Step 5**

(Optional) Repeat Steps 3 and 4 to assign tail drop thresholds for other queue classes.

**Step 6**

Exits policy-map queue mode and enters global configuration mode.

- `exit`

**Example:**

```
switch(config-cmap-que)# exit
switch(config)#
```
### Configuring Bandwidth and Bandwidth Remaining for FEX

You can configure the bandwidth and bandwidth remaining on the ingress and egress queue to allocate a minimum percentage of the interface bandwidth to a queue.

**Note**

When a guaranteed bandwidth is configured, the priority queue must be disabled in the same policy map.

**Before you begin**

Before configuring the FEX, enable `feature-set fex`.

### SUMMARY STEPS

1. configure terminal
2. policy-map type queuing {[match-first] policy-map-name}
3. class type queuing class-name
4. Assign a minimum rate of the interface bandwidth or assign the percentage of the bandwidth that remains:
   - Bandwidth percent:
     
     \[
     \text{bandwidth \{percent \%}}
     \]
   - Bandwidth remaining percent:
     
     \[
     \text{bandwidth remaining percent \%}
     \]
5. (Optional) Repeat Steps 3 and 4 to assign tail drop thresholds for other queue classes.
6. exit
7. show policy-map [type queuing [policy-map-name | default-out-policy]]
8. copy running-config startup-config

---

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 7</td>
<td>show policy-map [type queuing [policy-map-name</td>
<td>default-out-policy]]</td>
</tr>
<tr>
<td>Example:</td>
<td>switch(config-pmap-c-que)# show policy-map type queuing shape_queues</td>
<td></td>
</tr>
<tr>
<td>Step 8</td>
<td>copy running-config startup-config</td>
<td>(Optional) Saves the running configuration to the startup configuration.</td>
</tr>
<tr>
<td>Example:</td>
<td>switch(config)# copy running-config startup-config</td>
<td></td>
</tr>
<tr>
<td>Step</td>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>------</td>
<td>------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 1</strong></td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>switch# configure terminal switch(config)#</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong></td>
<td>policy-map type queuing {[match-first] policy-map-name}</td>
<td>Configures the policy map of type queuing and then enters policy-map mode for the policy-map name you specify. Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>switch(config)# policy-map type queuing shape_queues switch(config-pmap-que)#</td>
<td></td>
</tr>
<tr>
<td><strong>Step 3</strong></td>
<td>class type queuing class-name</td>
<td>Configures the class map of type queuing and then enters policy-map class queuing mode. Class queuing names are listed in the previous System-Defined Type queuing Class Maps table.</td>
</tr>
<tr>
<td><strong>Example:</strong></td>
<td>switch(config-pmap-que)# class type queuing c-out-ql switch(config-pmap-c-que)#</td>
<td></td>
</tr>
</tbody>
</table>
| **Step 4** | Assign a minimum rate of the interface bandwidth or assign the percentage of the bandwidth that remains: | \* Bandwidth percent:
• Bandwidth percent:
  bandwidth \{percent percent\} 
• Bandwidth remaining percent:
  bandwidth remaining percent percent |
| **Example:** | switch(config-pmap-c-que)# bandwidth percent 25 switch(config-pmap-c-que)# bandwidth remaining percent 25 | |
| **Step 5** | (Optional) Repeat Steps 3 and 4 to assign tail drop thresholds for other queue classes. | |
| **Step 6** | exit | Exits policy-map queue mode and enters global configuration mode. |
| **Example:** | switch(config-cmap-que)# exit switch(config)# | |
| **Step 7** | show policy-map [type queuing [policy-map-name | default-out-policy]] | (Optional) Displays information about all configured policy maps, all policy maps of type queuing, a selected policy map of type queuing, or the default output queuing policy. |
| **Example:** | | |
### Configuring Priority

If you do not specify the priority, the system-defined egress pq queues behave as normal queues. For information on the system-defined type queuing class maps, see the "Using Modular QoS CLI" section.

You can configure only one level of priority on an egress priority queue. You use the system-defined priority queue class for the type of module to which you want to apply the policy map.

For the nonpriority queues, you can configure how much of the remaining bandwidth to assign to each queue. By default, the device evenly distributes the remaining bandwidth among the nonpriority queues.

---

**Note**

When a priority queue is configured, the other queues can only use the remaining bandwidth in the same policy map.

**Note**

When configuring priority for one class map queue (SPQ), you need to configure the priority for QoS group 3. When configuring priority for more than one class map queue, you need to configure the priority on the higher numbered QoS groups. In addition, the QoS groups need to be adjacent to each other. For example, if you want to have two SPQs, you have to configure the priority on QoS group 3 and on QoS group 2.

---

### SUMMARY STEPS

1. configure terminal
2. policy-map type queuing {[match-first] policy-map-name}
3. class type queuing class-name
4. priority [level value]
5. class type queuing class-name
6. bandwidth remaining percent percent
7. (Optional) Repeat Steps 5 to 6 to assign the remaining bandwidth for the other nonpriority queues.
8. exit
9. show policy-map [type queuing [policy-map-name | default-out-policy]]
10. copy running-config startup-config

DETAILED STEPS

<table>
<thead>
<tr>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 1</strong> configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td>switch# configure terminal</td>
<td></td>
</tr>
<tr>
<td>switch(config)#</td>
<td></td>
</tr>
<tr>
<td><strong>Step 2</strong> policy-map type queuing {[match-first] policy-map-name}</td>
<td>Configures the policy map of type queuing and then enters policy-map</td>
</tr>
<tr>
<td>Example:</td>
<td>mode for the policy-map name you specify. Policy-map names can</td>
</tr>
<tr>
<td>switch(config)# policy-map type queuing priority queue</td>
<td>contain alphabetic, hyphen, or underscore characters, are case</td>
</tr>
<tr>
<td>switch(config-pmap-que)#</td>
<td>sensitive, and can be up to 40 characters.</td>
</tr>
<tr>
<td><strong>Step 3</strong> class type queuing class-name</td>
<td>Configures the class map of type queuing and then enters policy-map</td>
</tr>
<tr>
<td>Example:</td>
<td>class queuing mode. Class queuing names are listed in the previous</td>
</tr>
<tr>
<td>switch(config-pmap-que)# class type queuing c-out-q1</td>
<td>System-Defined Type queuing Class Map table.</td>
</tr>
<tr>
<td>switch(config-pmap-c-que)#</td>
<td></td>
</tr>
<tr>
<td><strong>Step 4</strong> priority [level value]</td>
<td>Selects this queue as a priority queue. Only one priority level is</td>
</tr>
<tr>
<td>Example:</td>
<td>supported.</td>
</tr>
<tr>
<td>switch(config-pmap-c-que)# priority</td>
<td></td>
</tr>
<tr>
<td><strong>Step 5</strong> class type queuing class-name</td>
<td>(Optional) Configures the class map of type queuing and then enters</td>
</tr>
<tr>
<td>Example:</td>
<td>policy-map class queuing mode. Class queuing names are listed in the</td>
</tr>
<tr>
<td>switch(config-pmap-que)# class type queuing c-out-q2</td>
<td>previous System-Defined Type queuing Class Map table.</td>
</tr>
<tr>
<td>switch(config-pmap-c-que)#</td>
<td>Choose a nonpriority queue where you want to configure the remaining</td>
</tr>
<tr>
<td><strong>Step 6</strong> bandwidth remaining percent percent</td>
<td>bandwidth among the nonpriority queues.</td>
</tr>
<tr>
<td>Example:</td>
<td>Choose a nonpriority queue where you want to configure the remaining</td>
</tr>
<tr>
<td>switch(config-pmap-c-que)# bandwidth remaining percent 25</td>
<td>bandwidth among the nonpriority queues.</td>
</tr>
<tr>
<td>Command or Action</td>
<td>Purpose</td>
</tr>
<tr>
<td>-------------------</td>
<td>---------</td>
</tr>
<tr>
<td><strong>Step 7</strong></td>
<td>(Optional) Repeat Steps 5 to 6 to assign the remaining bandwidth for the other nonpriority queues.</td>
</tr>
<tr>
<td><strong>Step 8</strong></td>
<td>exit</td>
</tr>
<tr>
<td>Example: switch(config-cmap-que)# exit switch(config)#</td>
<td></td>
</tr>
<tr>
<td><strong>Step 9</strong></td>
<td>show policy-map [type queuing [policy-map-name</td>
</tr>
<tr>
<td>Example: switch(config)# show policy-map type queuing priority_queue1</td>
<td></td>
</tr>
<tr>
<td><strong>Step 10</strong></td>
<td>copy running-config startup-config</td>
</tr>
<tr>
<td>Example: switch(config)# copy running-config startup-config</td>
<td></td>
</tr>
</tbody>
</table>

### Configuring Priority for FEX

**Note**

Priority for FEX is not supported on the Cisco Nexus 9508 switch (NX-OS 7.0(3)F3(3)).

If you do not specify the priority, the system-defined egress pq queues behave as normal queues. For information on the system-defined type queuing class maps, see the "Using Modular QoS CLI" section.

You can configure only one level of priority on an egress priority queue. You use the system-defined priority queue class for the type of module to which you want to apply the policy map.

For the nonpriority queues, you can configure how much of the remaining bandwidth to assign to each queue. By default, the device evenly distributes the remaining bandwidth among the non-priority queues.

**Note**

When a priority queue is configured, the other queues can only use the remaining bandwidth in the same policy map.

**Note**

When configuring priority for one class map queue (SPQ), you need to configure the priority for QoS group 3. When configuring priority for more than one class map queue, you need to configure the priority on the higher numbered QoS groups. In addition, the QoS groups need to be adjacent to each other. For example, if you want to have two SPQs, you have to configure the priority on QoS group 3 and on QoS group 2.
Before you begin

Before configuring the FEX, enable `feature-set fex`.

SUMMARY STEPS

1. `configure terminal`
2. `policy-map type queuing { [match-first] policy-map-name }
3. `class type queuing class-name`
4. `priority [level value]
5. `class type queuing class-name`
6. `bandwidth remaining percent percent
7. (Optional) Repeat Steps 5 to 6 to assign the remaining bandwidth for the other nonpriority queues.
8. `exit`
9. `show policy-map [type queuing [policy-map-name | default-out-policy]]`
10. `copy running-config startup-config`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 1 | `configure terminal`
Example:
```
switch# configure terminal
switch(config)#
```
| Enters global configuration mode. |
| Step 2 | `policy-map type queuing { [match-first] policy-map-name }
Example:
```
switch(config)# policy-map type queuing priority_queue1
switch(config-pmap-que)#
```
| Configures the policy map of type queuing and then enters policy-map mode for the policy-map name you specify. Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters. |
| Step 3 | `class type queuing class-name`
Example:
```
switch(config-pmap-que)# class type queuing c-out-q3
switch(config-pmap-c-que)#
```
| Configures the class map of type queuing and then enters policy-map class queuing mode. Class queuing names are listed in the previous System-Defined Type queuing Class Maps table. |
| Step 4 | `priority [level value]
Example:
```
switch(config-pmap-c-que)# priority
```
| Selects this queue as a priority queue. Only one priority level is supported.
| Note | FEX QoS priority is supported only on the c-out-q3 class map. |
| Step 5 | `class type queuing class-name`
Example:
```
switch(config-pmap-que)# class type queuing c-out-q3
switch(config-pmap-c-que)#
```
| (Optional) Configures the class map of type queuing and then enters policy-map class queuing mode. Class queuing names are listed in the previous System-Defined Type queuing Class Maps table. |
### Command or Action

<table>
<thead>
<tr>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choose a nonpriority queue where you want to configure the remaining bandwidth. By default, the system evenly distributes the remaining bandwidth among the nonpriority queues.</td>
</tr>
</tbody>
</table>

### Step 6

**bandwidth remaining percent** *percent*

**Example:**

```
switch(config-pmap-c-que)# bandwidth remaining percent 25
```

(Optional) Assigns the percent of the bandwidth that remains to this queue. The range is from 0 to 100.

### Step 7

(Optional) Repeat Steps 5 to 6 to assign the remaining bandwidth for the other nonpriority queues.

### Step 8

`exit`

**Example:**

```
switch(config-cmap-que)# exit
switch(config-)#
```

Exits policy-map queue mode and enters global configuration mode.

### Step 9

**show policy-map [type queuing [policy-map-name | default-out-policy]]**

**Example:**

```
switch(config)# show policy-map type queuing priority_queue1
```

(Optional) Displays information about all configured policy maps, all policy maps of type queuing, a selected policy map of type queuing, or the default output queuing policy.

### Step 10

**copy running-config startup-config**

**Example:**

```
switch(config)# copy running-config startup-config
```

(Optional) Saves the running configuration to the startup configuration.

---

### Example

This example shows how to configure the level of priority:

```
switch(config)# policy-map type queuing inq_pri
switch(config-pmap-que)# class type queuing c-in-q3
switch(config-pmap-c-que)# priority
switch(config-pmap-que)# class type queuing c-in-q2
switch(config-pmap-c-que)# bandwidth remaining percent 20
switch(config-pmap-que)# class type queuing c-in-q1
switch(config-pmap-c-que)# bandwidth remaining percent 40
switch(config-pmap-c-que)# class type queuing c-in-q-default
switch(config-pmap-c-que)# bandwidth remaining percent 40
```

---

### Configuring Traffic Shaping

You can configure traffic shaping on an egress queue to impose a minimum and maximum rate on it.
Configuring traffic shaping for a queue is independent of priority or bandwidth in the same policy map.

The system queuing policy is applied to both internal and front panel ports. When traffic shaping is enabled on the system queuing policy, traffic shaping is also applied to the internal ports. As a best practice, do not enable traffic shaping on the system queuing policy.

Traffic shaping is not supported on the Cisco Nexus 9300 40G ports.

The lowest value that the egress shaper can manage, per queue, is 100 Mbps on Cisco Nexus 9200 series, 9300-EX/FX/FX2, and 9700-EX/FX switches.

Before you begin
Configure random detection minimum and maximum thresholds for packets.

SUMMARY STEPS

1. `configure terminal`
2. `policy-map type queuing {
   [match-first] policy-map-name
   }`
3. `class type queuing class-name`
4. `shape min value {bps | gbps | kbps | mbps | pps} max value {bps | gbps | kbps | mbps | pps}`
5. (Optional) Repeat Steps 3 and 4 to assign tail drop thresholds for other queue classes.
6. `show policy-map [type queuing [policy-map-name | default-out-policy]]`
7. `copy running-config startup-config`

DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 1 | `configure terminal`
Example:
```
switch# configure terminal
switch(config)#
```
| | Enters global configuration mode. |
| Step 2 | `policy-map type queuing {
   [match-first] policy-map-name
   }`
Example:
```
switch(config)# policy-map type queuing shape_queues
shape_queues
switch(config-pmap-que)#
```
| | Configures the policy map of type queuing and then enters policy-map mode for the policy-map name you specify. Policy-map names can contain alphabetic, hyphen, or underscore characters, are case sensitive, and can be up to 40 characters. |
## Configuring Queuing and Scheduling

### Applying a Queuing Policy on a System

You apply a queuing policy globally on a system.

**SUMMARY STEPS**

1. configure terminal
2. system qos

### Command or Action

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
</table>
| Step 3 | class type queuing *class-name*  
**Example:**
switch(config)# class type queuing c-out-q-default  
switch(config-pmap-c-que)# | Configures the class map of type queuing and then enters policy-map class queuing mode. Class queuing names are listed in the previous System-Defined Type queuing Class Maps table. |
| Step 4 | shape min *value* {bps | gbps | kbps | mbps | pps} max *value* {bps | gbps | kbps | mbps | pps}  
**Example:**
switch(config-pmap-c-que)# shape min 10 bps max 100 bps | Assigns a minimum and maximum bit rate on an output queue. The default bit rate is in bits per second (bps).  
The example shows how to shape traffic to a minimum rate of 10 bits per second (bps) and a maximum rate of 100 bps. |
| Step 5 | (Optional) Repeat Steps 3 and 4 to assign tail drop thresholds for other queue classes. | |
| Step 6 | show policy-map [type queuing [policy-map-name | default-out-policy]]  
**Example:**
switch(config)# show policy-map type queuing shape_queues | (Optional) Displays information about all configured policy maps, all policy maps of type queuing, a selected policy map of type queuing, or the default output queuing policy. |
| Step 7 | copy running-config startup-config  
**Example:**
switch(config)# copy running-config startup-config | (Optional) Saves the running configuration to the startup configuration. |
3. **service-policy type queuing output** `{policy-map-name | default-out-policy}`

### DETAILED STEPS

<table>
<thead>
<tr>
<th>Step</th>
<th>Command or Action</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1</td>
<td>configure terminal</td>
<td>Enters global configuration mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>switch# configure terminal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>switch(config)#</td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>system qos</td>
<td>Enters system qos mode.</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>switch (config)# system qos</td>
<td></td>
</tr>
<tr>
<td></td>
<td>switch (config-sys-qos)#</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td>service-policy type queuing output `{policy-map-name</td>
<td>default-out-policy}`</td>
</tr>
<tr>
<td></td>
<td>Example:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>switch (config-sys-qos)# service-policy type queuing map1</td>
<td></td>
</tr>
</tbody>
</table>

**Note**
- The **output** keyword specifies that this policy map should be applied to traffic transmitted from an interface.
- To restore the system to the default queuing service policy, use the **no** form of this command.

### Verifying the Queuing and Scheduling Configuration

Use the following commands to verify the queuing and scheduling configuration:

<table>
<thead>
<tr>
<th>Command</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>show class-map [type queuing [class-name]]</code></td>
<td>Displays information about all configured class maps, all class maps of type queuing, or a selected class map of type queuing.</td>
</tr>
<tr>
<td>`show policy-map [type queuing [policy-map-name</td>
<td>default-out-policy]]`</td>
</tr>
<tr>
<td><code>show policy-map system</code></td>
<td>Displays information about all configured policy maps on the system.</td>
</tr>
</tbody>
</table>

### Controlling the QoS Shared Buffer

The QoS buffer provides support per port/queue and shared space. You can control the QoS buffer that is shared by all flows by disabling or restricting reservations.
The `hardware qos min-buffer` command is used to control the QoS shared buffer.

| `hardware qos min-buffer [all|default|none]` | • all  
|                                           | Current behavior where all reservations are enabled ON).  
|                                           | • default  
|                                           | Enables reservations only for qos-group-0.  
|                                           | • none  
|                                           | Disables reservations for all qos-groups. |

The `show hardware qos min-buffer` command is used to display the current buffer configuration.

## Monitoring the QoS Packet Buffer

The Cisco Nexus 9000 Series device has a 12-MB buffer memory that divides into a dedicated per port and dynamic shared memory. Each front-panel port has four unicast queues and four multicast queues in egress. In the scenario of burst or congestion, each egress port consumes buffers from the dynamic shared memory.

You can display the real-time and peak status of the shared buffer per port. All counters are displayed in terms of the number of cells. Each cell is 208 bytes in size. You can also display the global level buffer consumption in terms of consumption and available number of cells.

### Note

Monitoring the shared buffer on ALE enabled devices is not supported for the port level.

### Note

In the examples shown in this section, the port numbers are Broadcom ASIC ports.

This example shows how to clear the system buffer maximum cell usage counter:

```
switch# clear counters buffers  
Max Cell Usage has been reset successfully
```

This example shows how to set a buffer utilization threshold for a specific module:

```
switch(config)# hardware profile buffer info port-threshold module 1 threshold 10  
Port threshold changed successfully
```

### Note

The buffer threshold feature is not enabled for ports if they have a no-drop class configured (PFC).
The configured threshold buffer count is checked every 5 seconds against all the buffers used by that port across all the queues of that port.

You can configure the threshold percentage configuration for all modules or for a specific module, which is applied to all ports. The default threshold value is 90% of the switch cell count of shared pool SP-0. This configuration applies to both Ethernet (front panel) and internal (HG) ports.

The buffer threshold feature is not supported for ACI capable device ports.

This example shows how to display the interface hardware mappings:

```
eor15# show interface hardware-mappings
Legends:
  SMod  - Source Mod. 0 is N/A
  Unit  - Unit on which port resides. N/A for port channels
  HPort - Hardware Port Number or Hardware Trunk Id:
  FPort - Fabric facing port number. 255 means N/A
  NPort - Front panel port number
  VPort - Virtual Port Number. -1 means N/A
```

<table>
<thead>
<tr>
<th>Name</th>
<th>Ifindex</th>
<th>SMod</th>
<th>Unit</th>
<th>HPort</th>
<th>FPort</th>
<th>NPort</th>
<th>VPort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eth2/1</td>
<td>1a080000</td>
<td>4</td>
<td>0</td>
<td>13</td>
<td>255</td>
<td>0</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/2</td>
<td>1a080200</td>
<td>4</td>
<td>0</td>
<td>14</td>
<td>255</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/3</td>
<td>1a080400</td>
<td>4</td>
<td>0</td>
<td>15</td>
<td>255</td>
<td>2</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/4</td>
<td>1a080600</td>
<td>4</td>
<td>0</td>
<td>16</td>
<td>255</td>
<td>3</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/5</td>
<td>1a080800</td>
<td>4</td>
<td>0</td>
<td>17</td>
<td>255</td>
<td>4</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/6</td>
<td>1a080a00</td>
<td>4</td>
<td>0</td>
<td>18</td>
<td>255</td>
<td>5</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/7</td>
<td>1a080c00</td>
<td>4</td>
<td>0</td>
<td>19</td>
<td>255</td>
<td>6</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/8</td>
<td>1a080e00</td>
<td>4</td>
<td>0</td>
<td>20</td>
<td>255</td>
<td>7</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/9</td>
<td>1a081000</td>
<td>4</td>
<td>0</td>
<td>21</td>
<td>255</td>
<td>8</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/10</td>
<td>1a081200</td>
<td>4</td>
<td>0</td>
<td>22</td>
<td>255</td>
<td>9</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/11</td>
<td>1a081400</td>
<td>4</td>
<td>0</td>
<td>23</td>
<td>255</td>
<td>10</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/12</td>
<td>1a081600</td>
<td>4</td>
<td>0</td>
<td>24</td>
<td>255</td>
<td>11</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/13</td>
<td>1a081800</td>
<td>4</td>
<td>0</td>
<td>25</td>
<td>255</td>
<td>12</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/14</td>
<td>1a081a00</td>
<td>4</td>
<td>0</td>
<td>26</td>
<td>255</td>
<td>13</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/15</td>
<td>1a081c00</td>
<td>4</td>
<td>0</td>
<td>27</td>
<td>255</td>
<td>14</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/16</td>
<td>1a081e00</td>
<td>4</td>
<td>0</td>
<td>28</td>
<td>255</td>
<td>15</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/17</td>
<td>1a082000</td>
<td>4</td>
<td>0</td>
<td>29</td>
<td>255</td>
<td>16</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/18</td>
<td>1a082200</td>
<td>4</td>
<td>0</td>
<td>30</td>
<td>255</td>
<td>17</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/19</td>
<td>1a082400</td>
<td>4</td>
<td>0</td>
<td>31</td>
<td>255</td>
<td>18</td>
<td>-1</td>
</tr>
<tr>
<td>Eth2/20</td>
<td>1a082600</td>
<td>4</td>
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Configuration Examples for Queuing and Scheduling

In this section you can find examples of configuring queuing and scheduling.

Example: Configuring WRED on Egress Queues

The following example shows how to configure the WRED feature on an egress queue:

```plaintext
configure terminal
class-map type queuing match-any c-out-q1
  match qos-group 1
class-map type queuing match-any c-out-q2
  match qos-group 1
policy-map type queuing wred
  class type queuing c-out-q1
    random-detect minimum-threshold 10 bytes maximum-threshold 1000 bytes
class type queuing c-out-q2
  random-detect threshold burst-optimized ecn
```

Example: Configuring Traffic Shaping

The following example shows how to configure traffic shaping using 1000 packets per second (pps):

```plaintext
configure terminal
class-map type queuing match-any c-out-q1
  match qos-group 1
class-map type queuing match-any c-out-q2
  match qos-group 1
policy-map type queuing pqu
  class type queuing c-out-q1
    shape min 100 pps max 500 pps
class type queuing c-out-q2
    shape min 200 pps max 1000 pps
show policy-map type queuing pqu
```
Example: Configuring Traffic Shaping